# DOCUMENT RESUME

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|---|---|
| ED 201 862 | CE 028 973 |

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|---|---|
| TITLE | Competency-Based Education Curriculum for Machine Shop. Student Material. |
| INSTITUTION | Associated Educational Consultants, Inc., Pittsburgh, Pa.; West Virginia State Vocational Curriculum Lab., Cedar Lakes. |
| SPONS AGENCY | West Virginia State Dept. of Education, Charleston. Bureau of Vocational, Technical, and Adult Education. |
| PUB DATE | Dec 80 |
| NOTE | 593p.: For a related document see CE 028 972. |
| AVAILABLE FROM | Vocational Curriculum Laboratory, Cedar Lakes Conference Center, Ripley, WV 25271. |
| EDRS PRICE | MF03/PC24 Plus Postage. |
| DESCRIPTORS | Competence; *Competency Based Education; Course Content; Curriculum; Equipment; Instructional Materials; Learning Activities; *Learning Modules; *Machine Tool Operators; *Machine Tools; *Machinists; Numerical Control; Secondary Education; Self Evaluation (Individuals); *Trade and Industrial Education; Vocational Education |
| IDENTIFIERS | West Virginia |

ABSTRACT

This publication contains the student material for the machine shop competency-based education curriculum for secondary students in West Virginia. It has been developed to facilitate the learning of skills necessary for a career as a machinist. The tasks in the curriculum are those actually performed on the job. The materials are intended for use by students and/or the instructor. The student material is made up of 16 units, divided into modules. Each module is made up of several tasks (job-related competencies). For each task there is a student competency sheet that requires performance of five or more steps in order to accomplish the task. Each student competency sheet contains a performance checklist, a "test"--items needed, task to be done, and standard (how well the task must be done)--and learning activities. Some student competency sheets have extra information sheets, a self-check test, or an instructor check sheet. Job titles covered by the tasks in the modules include machinist, electrical discharge machine set-up operator, numerical control machine operator, and machine shop supervisor (tool). (KC)

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ED201862

# STUDENT MATERIAL

for

# COMPETENCY-BASED EDUCATION CURRICULUM

for

# MACHINE SHOP

U S DEPARTMENT OF HEALTH,
EDUCATION & WELFARE
NATIONAL INSTITUTE OF
EDUCATION

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CE028973

This student material was developed by Associated Educational Consultants, Inc., through the cooperation and support of the Bureau of Vocational, Technical and Adult Education, West Virginia Department of Education, Charleston, West Virginia.

December 1980

# PREFACE

This competency-based education (CBE) Machine Shop Curriculum was developed for West Virginia by Associated Educational Consultants, Inc., Pittsburgh, Pennsylvania, with the help of teachers of machine shop programs. The effort was coordinated by the staff of the Bureau of Vocational, Technical and Adult Education.

The Bureau began advocating CBE curriculum in 1974. Since that time, West Virginia has produced over twenty CBE curricula in various occupational areas. We also have a number of CBE curricula currently in the process of being developed and/or field-tested. This Machine Shop curriculum was disseminated to West Virginia teachers through workshops in the Spring of 1981. Additional copies of the curriculum are available from:

Vocational Curriculum Laboratory
Cedar Lakes Conference Center
Ripley, West Virginia 25271
(304) 372-8673

I trust this curriculum will help your program. Any suggestions you may have for improving it may be sent to our State Curriculum Lab. Through this feedback we plan to continually update our materials.

VOCATIONAL, TECHNICAL AND ADULT EDUCATION
Clarence E. Burdette
Clarence E. Burdette
Assistant State Superintendent of Schools

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# ACKNOWLEDGMENTS

The planning, organizing, and coordinating of the development of this competency-based curriculum for machine shop required the working together of several people of specialized skills and abilities. Associated Educational Associates, Inc. (AEC) relied heavily on the guidance of Mr. Kyle McGraw, formerly of the Bureau of Vocational, Technical and Adult Education and, particularly, Dr. Fred W. Harrington, Coordinator of Curriculum Development.

Several teachers of the machine shop programs in West Virginia provided assistance by submitting lists of references used in their programs as well as curriculum information.

We are especially indebted to Mr. Ronald Harrington, North Hills School District, Pittsburgh, Pennsylvania, who served not only as Content Consultant, but also as advisor and coordinator. Thanks are also due to Mr. James E. Litzinger, Central Westmoreland Area Vocational-Technical School, and Mr. Russell W. Busch, Coordinator of Apprentice Programs, Homestead Works, United States Steel Corporation.

A debt of gratitude is owed also to those many people who took time from their busy schedules to respond to the task validation survey: instructors of machine shop programs in West Virginia and Pennsylvania, and machinists and supervisors of machinists in both states.

# STUDENT CURRICULUM

## INTRODUCTION

This material is designed as a student Machine Shop Competency-Based Education (CBE) curriculum. It has been developed to facilitate the learning of skills necessary for a career as machinist. The tasks in this curriculum are those actually performed "on the job." The Student Competency sheets are intended for use by students and/or the instructor.

A Teacher's Guide accompanies this curriculum. The guide contains an explanation of the curriculum--its validated basis, the construction, and the uses. It also contains competencies by job title, a list of references used in the curriculum, equipment lists, and suggested evaluation instruments.

# HOW TO USE THIS CURRICULUM

As you read the Table of Contents, you noticed that the competencies of this curriculum have been grouped into major sections called "Units." A "unit" is a major segment of work made up of related tasks.

A sub-group, within a Unit, is called a "Module." Each Module is made up of several closely-related "Tasks." These have been grouped together as a Module because these related skills may be learned at about the same time.

A "Task" is a job-related competency which constitutes logical and necessary steps in the performance of a segment of the worker's overall responsibilities. Another way of saying this is that a task has a definite beginning and ending point, and between the beginning and ending there are definite steps to be performed.

Each Student Competency Sheet (SCS) pertains to a single "task," which requires performance of five (5) or more steps in order to accomplish the task. In other words, when satisfactory performance of all the "steps" is attained, as listed in the "Performance Checklist," the competence required for that "Task" has been mastered.

Turn to a Student Competency Sheet and look at the format.

In the upper section of the SCS (above the first solid line) you see "Unit" and a Roman numeral and the name of the unit on the line below the words "Student Competency Sheet." The second line shows Module A or B or C, etc., and the name of the group of related tasks. The third line tells you the number (1, 2, 3, etc.) and the name of the Task. This is the job-related competency.

## What To Do With a Student Competency Sheet

The first major section of the Student Competency Sheet (SCS) is the "Performance Checklist." The steps listed here serve two purposes. First, they tell exactly what must be done to perform the task. The steps are listed in order. The task can be performed by following the Performance Checklist as it is numbered. As the steps are performed, evaluation can be done. Thus, the second use of the Performance Checklist is as a competency-based "test": can this job be done or do skills need to be sharpened in one or more of the steps?

The second section of the SCS tells more about the competency "test." The "Test" portion lists:

1. Items Needed - what will be needed (equipment, tools, materials, etc.) to perform the task.
2. Task - what must be done.
3. Standard - how well the task must be done or, in other words, the standard to which the task must be performed.

The last section of the SCS suggests "Learning Activities" which are recommended in order to be able to perform the task. They include things that can be read, seen, and heard. And they suggest situations for practicing skills related to the task. Many additional activities are possible. By the time some or all of the Learning Activities have been completed, why and how to perform the task should be mastered.

Performance means:

1. Understanding why the task is done and what's involved in understanding the why's.
2. Being able to perform the task efficiently and effectively.

3. Being able to feel comfortable while performing the task and becoming a "good" worker. A "good" worker should be cooperative and confident and be able to relay confidence to others.

Many Student Competency Sheets are too long to fit on one page. Don't overlook that second page!

## SCS Packets

Some Student Competency Sheets will have extra pages immediately following them. These pages may be Information Sheets, which supplement textbook or audio-visual information. There may also be a Self-Check Test. (Questions on a Self-Check Test should be answered without looking at the answers. After completing the test, then answers can be checked and discussed.) There may be an "Instructor Check Sheet," which is also a guide. Sometimes the items on the Instructor Check Sheet are the same as listed in the Performance Checklist on the SCS; other times, two or more steps have been combined for evaluation purposes.

These supplements to an SCS will be keyed in the upper right-hand corner of the page. For example, I-A-1 means Unit I, Module A, Task 1. When additional pages are included after the first page of a Student Competency Sheet, each page will be identified for example as $\underset{2}{\text{I-A-1}}$, $\underset{3}{\text{I-A-1}}$, etc.

The only exceptions to this numbering system are the units called Unit A, Unit B, etc. (alphabetical instead of Roman numerals). For these units there are no Modules. There are only Tasks, which are numbered 1, 2, 3, etc. Therefore, additional pages which accompany the SCS for Unit A, Task 1, are called $\underset{2}{\text{A-1}}$, $\underset{3}{\text{A-1}}$, etc.

When working with a Student Competency Sheet, be sure all the pages included for that task are identified. Also, check to see if any other supplemental material is available.

Your instructor will evaluate your performance of each task. There will also be some written tests. The instructor will give you these tests to help determine your grade.

## MACHINE SHOP CURRICULUM

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UNIT MODULE TASK

A. Employment Opportunities

1. Look for a job
2. Write a personal data sheet (resume)
3. Complete a job application form
4. Prepare for a job interview

B. Human Relations

1. Understand yourself
2. Understand successful work attitudes
3. Use principles of human relations

C. Safety

1. Maintain personal safety
2. Maintain general shop safety

D. Basic Mathematics

1. Compute whole numbers
2. Compute common fractions
3. Compute decimal fractions
4. Calculate/express percentages, averages, and estimates
5. Use basic measuring tools

I. Maintaining Shop Facilities and Work Areas

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1. Dispose of scrap metal, chips or shavings, and trash or waste materials
2. Sweep and clean shop facility

B. Maintenance

1. Perform custodial tasks
2. Paint facilities

C. Safety

1. Inspect work area for safe working environment
2. Inspect work equipment for safe working environment

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A. Measurement

1. Take micrometer readings
2. Use machining handbooks, charts, and tables to aid in mathematical calculations
3. Apply dimensions of parts from blueprints or specifications to job requirements
4. Convert to metric measurement
5. Calculate tolerances or allowances for proper fits
6. Measure stock

B. Calculating Materials

1. Calculate stock utilization in machine work
2. Calculate amount of material to be removed to obtain correct work limits
3. Determine material strength according to standard raw stock sizes
4. Test for hardness

C. Calculating Speed

1. Calculate conversion of revolutions per minute (RPM) to surface feet per minute (SFPM) for grinder application
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3. Calculate change gearing for threading

D. Calculating for Machine Set-up

1. Determine clearance, relief and rake of cutting tools
2. Calculate gear blank specifications for indexing

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1. Hand sharpen cutting tools with abrasive stones

B. Cutting and Reaming

1. Cut materials with hand hacksaws
2. Ream holes with hand reamers
3. Thread with hand taps
4. Thread with dies

UNIT MODULE TASK

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1. Disassemble and assemble parts
2. Hone and lap surfaces
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5. Remove frozen or seized parts
6. Remove and install pins
7. Remove defective splines and replace with new splines

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2. Clean and lubricate arbor press
3. Clean hydraulic press
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2. Set up press and assemble parts with presses
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4. Straighten miscellaneous parts with presses
5. Set up and punch materials with press
6. Set up and broach material with press

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1. Inspect drill presses for safe operational condition
2. Perform preventive maintenance on drill press

B. Setting Up for Drilling

1. Consider material of work piece to be drilled
2. Determine holding technique
3. Mount and secure work in holding device
4. Select tool or cutter for drill press operation
5. Sharpen drill using grinding wheel, freehand technique and using drill grinding jig
6. Secure tool or cutter in drill press spindle
7. Select sleeve to suit drill
8. Set drill press for proper feeds and speeds for operation performed
9. Center punch hole location

C. Drilling

1. Drill hole to size
2. Countersink hole to drawing requirements
3. Counterbore to depth specified in blueprint
4. Spot-face work piece
5. Ream hole to size
6. Hand tap hole to blueprint specifications
7. Use tapping attachment to tap hole
8. Use automatic feed on drill press

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1. Determine type of steel to be sawed
2. Select appropriate blades
3. Remove and replace saw blades
4. Select and set speeds and feeds for sawing operations
5. Cut and weld bandsaw blades to insert for contour sawing

B. Cutting

1. Measure material and cut off material with power hacksaw
2. Sawing with a metal bandsaw to scribed lines

C. Saw Maintenance

1. Perform preventive maintenance on bandsaw
2. Perform preventive maintenance on power hacksaw

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3. Align lathe centers using accurate measurement
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3. Rough cut and finish cut with lathe
4. Using taper attachment, cut long external tapered surfaces

5. Using compound rest, cut short external tapered surfaces
6. Cut internal tapered surfaces
7. Perform contour, angular, or radii cuts with lathe

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2. Knurl parts with lathe
3. Perform grinding operation
4. Perform spinning operation using forming tool

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3. Counterbore holes with lathe
4. Countersink holes using lathe
5. Ream holes with lathe

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2. Die cut threads with lathe using die heads
3. Cut external threads with lathe
4. Cut internal threads with lathe
5. Tap threads with lathe - hand tap internal threads
6. Rechase threads on lathe

F. Lathe Maintenance

1. Perform preventive maintenance on lathe
2. Inspect lathe for safe operation

VIII. Operating Shapers

A. Setting Up

1. Align shaper attachment, work piece, and cutting tool
2. Select and set speeds and feeds of shapers
3. Select, shape, and sharpen cutting tools for shaper operation

B. Cutting Operation

1. Surfacing
2. Machine slots and keyways

C. Maintenance

1. Performing preventive maintenance
2. Inspect for safe operation

UNIT MODULE TASK

IX. Operating Grinding Machines

A. Setting Up for Grinding

1. Inspect grinding wheels
2. Balance grinding wheels
3. Dress and true grinding wheel
4. Attach and align materials for grinding operations
5. Set up grinder to run work piece between centers
6. Set up grinder to run on magnetic chuck - surface grinder
7. Select and set speeds and feeds of power feed grinders

B. Grinding Operations

1. Perform grinding machine operations as per set-up
2. Cut off or part materials with grinding machines
3. Polish with grinding machine
4. Measure, inspect, and rework work piece on grinding machines
5. Set up and perform surface grinding operations
6. Set up, grind, and sharpen preshaped lathe tools - tool grinder
7. Set up grinder and sharpen plain milling cutters - universal grinder
8. Set up grinder and shape cold chisels - tool grinder

C. Using Abrasive Belt Grinder

1. Set up abrasive belt grinder
2. Use abrasive belt grinder

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1. Store grinding wheels
2. Perform preventive maintenance on grinder
3. Inspect grinder for safe operation

X. Operating Milling Machines

A. Setting Up

1. Align milling machine attachments
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3. Select and set speeds and feeds for milling work

B. Boring and Drilling

1. Drill holes with milling machine
2. Bore holes with milling machines
3. Perform reaming operations
4. Bore to remove damaged bushing
5. Bore to finish bushing

C. Milling

1. Square metal using table vise
2. Square metal using dividing head
3. Mill an angle
4. Perform end milling
5. Perform straddle milling operations on the horizontal mill
6. Mill cylindrical work
7. Mill an external radius
8. Mill gears
9. Perform form milling
10. Perform cutting-off operations
11. Perform flycutting operations
12. Cut external keyway
13. Duplicate on the profile milling machine

D. Milling Machine Maintenance

1. Perform preventive maintenance on milling machine
2. Inspect milling machine for safe operation

XI. Performing Metalwork Operations

A. Measuring

1. Determine accuracy of precision measurement instruments with gauge blocks
2. Use depth gauges
3. Measure with height gauges
4. Measure with sine bar

B. Setting Up

1. Clamp work in holding device
2. Cut metal stock

C. Performing Fabrication Operations

1. Operate cylindrical grinder
2. Operate hone - cylinder hone
3. Perform bench filing
4. Polish metal
5. Heat treat metal
6. Fabricate special metalworking tools

UNIT MODULE TASK

XII. Designing and Planning Machine Work

  A. Design

    1. Interpret technical orders, standards, and specifications for machine work
    2. Make sketches of parts to be machined
    3. Perform layout for precision machine work using layout instruments
    4. Perform layout for precision machine work using milling machine

XIII. Performing Supervisory Functions

  A. Maintaining Supplies and Materials

    1. Inventory supplies and materials
    2. Order and receive stock

  B. Supervising Safety and Operations

    1. Supervise maintenance of shop safety equipment, safe operations, and set-up of machinery
    2. Supervise machine use and operation

  C. Maintaining Quality Control

    1. Conduct follow-up on product quality control standards

XIV. Maintaining Machines and Tools

  A. Cleaning and Storing Tools

    1. Inspect and repair hand tools
    2. Clean and store hand tools, cutters, fixtures, jigs or attachments
    3. Store precision tools

  B. Maintaining Machines

    1. Install, level and fasten down machines
    2. Inspect and remove, replace or adjust machine guards
    3. Remove machine parts
    4. Inspect and change drive pulleys or belts
    5. Replace and adjust machine parts
    6. Select coolants, cutting oils or compounds for machine operation
    7. Scrape and paint machines

UNIT MODULE TASK

XV. Performing Production Machinist Line Work

- A. Numerical Control (N/C)
  1. Transfer drawing to tape
  2. Turn with N/C machine
  3. Mill with N/C machine
  4. Drill with N/C machine
- B. Electrical Discharge Machine (EDM)
  1. Set up operation per drawing specifications

# UNIT A

# EMPLOYMENT OPPORTUNITIES

## Terminal Objectives

Upon completion of the modules in this unit, you will:

- Know where and how to look for a job.
- Write a personal data sheet (resume).
- Complete a job application form.
- Be prepared for a job interview.

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## Student Competency Sheet

Unit A: EMPLOYMENT OPPORTUNITIES

Task 1: LOOK FOR A JOB

---

Performance Checklist

1. Check the Dictionary of Occupational Titles for titles of machinst occupations that interest you.
2. Check the Occupational Outlook Handbook for information relating to each of these jobs.
3. Consult the local telephone book for companies that hire employees under the job titles that interest you.
4. Make a list of the employers' names, addresses, and telephone numbers.
5. Look in the Classified Ads section of local, regional, and statewide newspapers for employers that are looking for employees with job titles that interest you.
6. Make an appointment with the school placement officer (if one is available) or the guidance person in charge of job placement. Find out what jobs are available on the local, regional, state, and national level. (Find out also what degree of training and experience is usually required for these jobs. Discuss with the counselor the possibilities for additional training after high school: schools that offer courses or programs you are interested in; possibilities for financial aid; and how to apply for financial aid.)
7. Visit local employers and find out what the working conditions are, distance needed to travel, employee benefits, competencies needed, and salary for the job you are interested in.

Test

Items Needed:

1. What Color is Your Parachute?, Bolles, Penn Speed Press
2. Dictionary of Occupational Titles, U.S. Department of Labor, Employment and Training Administration
3. Occupational Outlook Handbook, U.S. Department of Labor, Bureau of Labor Statistics
4. Local, regional, and statewide newspapers
5. Telephone directories (Yellow Pages)
6. Paper and pencil
7. Local employers
8. Guidance counselor

Task: Research the employment opportunities for machinists.

Standard:

1. Must be able to identify several (at least three (3)) jobs that interest you.
2. Must be able to describe the responsibilities of the machinist.

3. Must be aware of the employment market for jobs that interest you.
4. Must be able to match competencies you have developed with those necessary to obtain a job or jobs that interest you.

---

Learning Activities

1. Read What Color Is Your Parachute?

2. See and participate in Units IX and X, "Job-Seeking Skills," Job Survival Skills Program. (Singer, 1973)

3. Read Information Sheet A-1. Then:

   a. Find other job descriptions about machinist jobs in the Dictionary of Occupational Titles. (D.O.T. codes 600 through 609)
   b. Copy the descriptions of at least three (3) that interest you.
   c. Discuss the jobs with your instructor and class: what skills (competencies) are needed? What are the local employment possibilities?

4. Attend a lecture-discussion on opportunities in machining.

   a. Talk about the major kinds of metal machine occupations.
   b. Make a list of the kinds of machining operations that interest you.

5. Write separate lists of:

   a. Things you like to do.
   b. Things you do not like to do.
   c. Things you feel you do well.
   d. Things other people have complimented you on.
   e. Equipment you can operate/use.
   f. Jobs you feel you would like to have.
   g. Places you would like to live and work.
   h. Your living expenses when you are working. (Be reasonable--"cut out the fat.")
   i. Advantages and disadvantages of the machining jobs that interest you.

6. Read "Machining Occupations," Occupational Outlook Handbook. Check the Index for other related job titles. Discuss with your class:

   a. Nature of the work
   b. Places of employment
   c. Training, other qualifications, and advancement
   d. Employment outlook
   e. Earnings and working conditions

7. Interview a person who is currently employed in a machining job that interests you.

8. Write a brief report about a person who is currently employed in a machining job that interests you.

9. Look for a job that interests you. (Use the Performance Checklist.)
NOTE: When you are actually job-hunting, apply for jobs at as many companies as you can find. Don't stop with one and "just hope." If only filing an application is involved, do several each day. If interviews are involved, you should do at least two a day.

10. Read one (1) of the following:

    a. Chapter 38, General Office Practice, 3rd Ed. (Archer, Brecker, Frakes, and Stewart), McGraw-Hill Book Co., 1968.
    b. Part 49, General Business for Economic Understanding, 11th Ed. (DeBrum, Haines, Malsbary, Daughtrey), South-Western Publishing Company, 1976.

11. See and participate in Unit X, Job Survival Skills Program.

## Information Sheet A-1

## LOOK FOR A JOB

### MACHINIST (All-Around Machinist), D.O.T. Code 600.280-022

Sets up and operates machine tools, and fits and assembles parts to make or repair metal parts, mechanisms, tools, or machines, applying knowledge of mechanics, shop mathematics, metal properties, and layout and machining procedures.

Studies specifications, such as blueprint, sketch, damaged part, or description of part to be replaced, to determine dimensions and tolerances of piece to be machined, sequence of operations, and tools, materials, and machines required.

Measures, marks, and scribes dimensions and reference points to lay out stock for machining (Lay-Out Worker).

Sets up and operates metal-removing machines, such as lathe, milling machine, shaper, or grinder, to machine parts to specifications.

Verifies conformance of work piece to specifications, using measuring instruments (Tool-Machine Set-Up Operator).

Positions and secures work piece in holding device, such as chuck or collet, or on surface plate or worktable with such devices as vises, V-blocks, and angle plates, and uses handtools, such as files, scrapers, and wrenches, to fit and assemble parts to assemblies or mechanisms.

Verifies dimensions and alignment with measuring instruments, such as micrometers, height gages, and gage blocks.

May operate mechanism or machine, observe operation, or test with inspection equipment, to diagnose malfunction of machine or to test repaired operations, when required.

May perform flame cutting and arc or gas welding operations, when required.

May develop specifications from general description and draw or sketch product to be made.

## Student Competency Sheet

Unit A: EMPLOYMENT OPPORTUNITIES

Task 2: WRITE A PERSONAL DATA SHEET (RESUME)

---

Performance Checklist

1. Gather all the important information about you in the following areas:
    a. Education you have had.
    b. Work experience you have had.
    c. Your accomplishments or honors.
    d. Relevant personal information.
    e. Names of people who know what type of person you are.
2. Assemble this information in outline form as follows:
    a. Personal information
        Name, address, telephone number, year of birth, health.
    b. Education and Training
        Name and address of high school, grade level completed, work-related subjects completed. If your instructor maintains a list of competencies you have mastered, include the information that such a list is available to your prospective employer.
    c. Military Service
        Branch of U.S. Military Service, rank at time of discharge, type of duty assignments.
    d. Employment (Work Experience)
        List in order, beginning with the most recent and going back to your first employment. List: employer, dates, job title, duties, salary, supervisor, and reason for leaving. Include work done on a co-op or on a volunteer basis. Briefly describe your duties for each job.
    e. Awards, Licenses, Honors, and Organizations
        Include any honors or offices held during school years in VICA or other club activities.
    f. Interests and hobbies
    g. Personal References
        Names, addresses, and telephone numbers of three (3) people you feel would recommend you for employment.
        NOTE: Always ask the person first before using someone's name.

Test

Items Needed: 1. Paper
2. Pen or pencil
3. Typewriter (recommended)

Task: Organize personal information about yourself to write a personal data sheet (sometimes called a "resume").

Standard: 1. The personal data sheet will be complete.
2. The personal data sheet will be written in a neat, orderly fashion (typewritten if possible).

---

## Learning Activities

1. If you do not already have a social security card, ask the school guidance counselor or placement officer how you can get one.

2. Develop a personal data sheet (resume) by following the steps outlined in the Performance Checklist:

   a. Use Information Sheet A-2 ("Write a Personal Data Sheet") as a guide to assemble information, then
   b. Write (neatly in pen) or type a personal data sheet (resume). You may use Information Sheet A-2a as a guide.

3. Read page 585, General Business for Economic Understanding, 11th Ed., (DeBrum, Haines, Malsbary, Daughtrey), Southwestern Publishing, Co., 1976.

4. See and participate in Unit XI, "Resume," of Job Survival Skills Program. (Singer, 1973)

Information Sheet A-2

## WRITE A PERSONAL DATA SHEET (RESUME)
(Collect Information About Yourself)

Name ______________________________
(First) (Middle) (Last)

Address ______________________________
(Street) (City) (State) (ZIP)

Telephone ______________

Date of Birth ______________ Weight ________ Height ________

General Health ______________________________

Job Objective (State clearly the kind of position, program, or area you are interested in.) ______________________________

______________________________

Elementary School Attended ______________ Dates ________

Junior High School Attended ______________ Dates ________

High School(s) Attended ______________________________

Major ______________ Year of Graduation ________

Technical Skills ______________________________

______________________________

Leadership Activities (Honors, Awards, Organizations, Licenses, etc.)

______________________________

______________________________

Work Experience (Briefly list jobs held, employers' names and addresses, length of service for each, brief description of duties, salary, supervisor, and reason for leaving. Include volunteer work.)

______________________________

______________________________

______________________________

Information Sheet A-2 (continued)

Interests and Hobbies ______________________________________________

____________________________________________________________________

References (Get permission to use names. Try to include people in business, in education, and a personal reference.) List name, address, telephone number.

1. _________________________________________________________________

2. _________________________________________________________________

3. _________________________________________________________________

## Information Sheet A-2a

## PERSONAL DATA SHEET

## ROBERT M. JOBSEEKER

### Personal Data:

Address: 124 Main Street
Charleston, West Virginia 25000

Telephone: (304) 123-4567

Date of Birth: August 28, 1961

Physical Condition: Excellent. Height--5' 11"; Weight--185

### Job Objective: Machinist

### Education:

| | |
|---|---|
| Thomas Jefferson High School<br>124 Independence Avenue<br>Charleston, West Virginia 25000 | Graduated 1979. Vocational education: Two years (completion) of Machine Shop program at John Quincy Adams Vocational Center |
| James Madison Junior High School<br>248 Independence Avenue<br>Charleston, West Virginia 25000 | Attended 1973-1976 |
| James Monroe Elementary School<br>490 Independence Avenue<br>Charleston, West Virginia 25000 | Attended 1967-1973 |

### Work Experience:

Employer: Nationwide Machine and Tool Company
489 Revolutionary Street
Charleston, West Virginia 25000

Dates: June, 1979 - September, 1979 (part-time)

Job Title: Assistant Custodian

Duties: Assisting with shop clean-up work, receiving shipments of stock and materials, storing stock and materials, locating and distributing stock and materials to personnel.

Information Sheet A-2a (continued)

Work Experience: (continued)

| | |
|---|---|
| Salary: | $3.10 per hour |
| Supervisor: | Mr. Harry Truemann |
| Reason for Leaving: | Reduction in work force at company; seeking full-time machining position. |

Awards, Licenses, Honors, and Organizations:

- Vocational Industrial Clubs of America (VICA)
  - Chapter Reporter (1978-79)
  - Participant, State Leadership Workshop (1979)
  - House of Delegates, State Leadership Conference (1978)
- Student Council Representative--James Madison Junior High School (1975-76)

Interests and Hobbies:

Ornamental Ironworking, Swimming, Bowling

References:

Mr. Harry Truemann
Shop Foreman
Nationwide Machine and Tool Company
489 Revolutionary Street
Charleston, West Virginia 25000 (304-347-0000)

Mr. Richard Nickson
Machine Shop Instructor
John Quincy Adams Vocational Center
111 Mt. Vernon Road
Charleston, West Virginia 25000 (304-000-3470)

Mr. Lyndon Jackson
(Machinist, Nationwide Machine and Tool Company)
126 Main Street
Charleston, West Virginia 25000 (304-123-3456)

## Student Competency Sheet

Unit A: EMPLOYMENT OPPORTUNITIES

Task 3: COMPLETE A JOB APPLICATION FORM

---

Performance Checklist

1. Read the application form carefully before filling it out.
2. Refer to your Personal Data Sheet (resume). Fill out all the blanks as they apply to you.
3. Draw a short line in the blanks that do not apply, or write N/A (not applicable).
4. Either print or write, as directed. (NOTE: Never use both.)
5. Use either a pen or a clear-writing pencil. (NOTE: Never use both.)
6. Do not use abbreviations.
7. Be neat, accurate, and honest with all information.
8. Always write your signature.
9. Do not write in the blanks that are to be used by the company.

Test

Items Needed:
1. Your Personal Data Sheet
2. Job application form
3. Ballpoint pen or pencil

Task: Complete the application form.

Standard:
1. The directions printed on the application form will be completed with 100% accuracy.
2. All information filled in on the application will be spelled correctly.
3. The completed application will be neat.
4. The completed application must be approved by your instructor.

---

Learning Activities

1. Obtain a job application form from your instructor. Locate the following spaces on the job application form:

   a. Personal Data
      (1) Date of Birth (DOB)
      (2) Place of Birth (POB)
      (3) Social Security Number (SSN)
      (4) Telephone number, including area code
      (5) Residence, including ZIP code
      (6) Marital status (if listed)
      (7) Picture (if requested)

   b. Educational Information
      (1) High school credits
      (2) Courses taken
      (3) Class rank
      (4) Co-curricular activities
      (5) Extra-curricular activities
      (6) Special awards and recognitions
   c. Military information
   d. Previous employment

2. Read and learn the terms listed on Information Sheet A-3 ("Terms to Know to Fill Out a Job Application").

   a. Discuss these terms with your class.
   b. Discuss these items with your instructor and class. Do any of them violate Civil Rights legislation?

3. Take the self-check test supplied by your instructor. (See Self-Check Test A-3.)

4. Practice completing an application for employment (obtain from your instructor).

5. Fill out a different application form provided by your instructor or an employer. Use the Performance Checklist whenever needed.

6. See and participate in Unit XII, "Packaging Your Skills: Application" in Job Survival Skills Program, Singer Career Systems, Rochester, NY, 1973.

7. Read: Pages 585-588, General Business for Economic Understanding, 11th Ed. (DeBrum, Haines, Malsbary, Daughtrey), Southwestern Publishing Co., 1976, or pages 522-523, General Office Practice, 3rd Ed. (Archer, Brecker, Frakes, Stewart), McGraw-Hill Book Company, 1968.

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## Information Sheet A-3

## TERMS TO KNOW TO FILL OUT A JOB APPLICATION

1. Nationality - country where a person is born.
2. Guardian - person in charge of the legal care of a youth.
3. Number of dependents - individuals who depend upon you for their support.
4. Ethnic group - caucasian (white), negroid (black), Indian, Asian, other.
5. Limitations - health or physical condition that may hinder a person on the job.
6. Capabilities - things you can do well.
7. Compensation - pay for time not able to work.
8. Naturalized citizen - a person who has gone through the legal process to become a U.S. citizen.
9. Natural born citizen - a person who is born in a country.
10. Fringe benefits - things given an employee other than money.
11. Wage - the hourly rate of pay.
12. Salary - monthly or yearly contract payments.
13. Supervisor - a person who works for another person or company.
14. Employee - a person who works for another person or company.
15. Employer - a person or company who hires another.
16. O.A.S.I. - Old Age Survivors Insurance.
17. Deduction - that which is taken from a pay check.
18. Federal withholding - tax money taken out for the U.S. Government.
19. State withholding - tax money taken out by the State Government.
20. Annuity - a form of saving money.
21. Gross Pay - the total amount paid before deductions.
22. Take home pay - the amount that is taken home.
23. Management - those who make decisions.
24. Personnel Manager - person who is in charge of people.
25. Job interview - the person-to-person contact between employee and employer.
26. F.I.C.A. - (Federal Insurance Compensation Act) - money taken out for Social Security.

## SELF-CHECK TEST
## A-3

Define the following terms:

1. Nationality - ______________________________
2. Guardian - ______________________________
3. Number of dependents - ______________________________
4. Ethnic group - ______________________________
5. Limitations - ______________________________
6. Capabilities - ______________________________
7. Compensation - ______________________________
8. Naturalized citizen - ______________________________
9. Natural born citizen - ______________________________
10. Fringe benefits - ______________________________
11. Wage - ______________________________
12. Salary - ______________________________
13. Supervisor - ______________________________
14. Employee - ______________________________
15. Employer - ______________________________
16. O.A.S.I. - ______________________________
17. Deduction - ______________________________
18. Federal withholding - ______________________________
19. State withholding - ______________________________
20. Annuity - ______________________________
21. Gross pay - ______________________________
22. Take home pay - ______________________________
23. Management - ______________________________
24. Personnel Manager - ______________________________
25. Job interview - ______________________________
26. F.I.C.A. - ______________________________

# Student Competency Sheet

## Unit A: EMPLOYMENT OPPORTUNITIES

### Task 4: PREPARE FOR A JOB INTERVIEW

---

Performance Checklist

1. Write a letter of application and ask for an interview. Or, go directly to the employer and ask for an interview.
2. Secure as much information as possible about the company and its services before the interview. Know what is made or sold, how large the business is, how many locations there are, kinds of jobs available, and qualifications necessary to perform them.
3. Get a good night's sleep before the interview.
4. Before going to the interview, make sure you have taken a shower or bath, brushed your teeth, combed your hair, and put on clean, neat clothes.
5. Be prompt for the interview.
6. Go alone.
7. Look pleasant.
8. Introduce yourself in a quiet, pleasant way.
9. Shake hands firmly.
10. Sit erect (if the prospective employer indicates that you should sit down).
11. Avoid signs of nervousness (such as tapping fingers or foot).
12. Look the interviewer in the eye.
13. Be ready to describe your competencies and qualifications to the interviewer.
14. Be ready to take a performance test if the job requires it.
15. Leave discussion of salary to the end of the interview.
16. Thank the interviewer before you leave.
17. Every interview should be followed up with a letter of appreciation.

Test

Items Needed:
1. An employer (either an actual prospective employer or another student who will act as interviewer)
2. List of competencies you have developed (or a simulated list)
3. Pen
4. List of questions to ask, things to remember at the interview

Task:
1. Prepare for a job interview.
2. Have a job interview (by a prospective employer or another student).

Standard: Your instructor will evaluate your preparation and performance.

---

Learning Activities

1. Complete the Pretest (Self-Check Test A-4).
2. Read one (1) of the following:
   a. Page 588, General Business for Economic Understanding, 11th Ed.
   b. Pages 519-521, General Office Practice, 3rd Ed.
3. Write a letter of application. (See Information Sheet A-4).
4. See and participate in Unit XIII, "Interview," Job Survival Skills Program.
5. Develop a list of machine shop competencies you have mastered.
6. Read and discuss the Information Sheets for this task:
   a. "Interviewing: A Skill, Not a Mystery" (Information Sheet A-4a)
   b. "Some Frequently Asked Questions During the Interview" (Information Sheet A-4b)
   c. "Things to Remember at the Interview" (Information Sheet A-4c)
   d. "Factors Which Frequently Lead to Rejection During the Job Interview" (Information Sheet A-4d)
7. Before going to the interview, develop a check list of things to ask.
8. Discuss, with instructor and class, how to handle an interviewer's questions that violate civil rights. (For example, "What church do you attend?")
9. Develop a list of things to remember to tell about yourself at the interview. (Keep this in a coat pocket or wallet, but use it only when needed.)
10. Complete "Check List to be Used Before Going for an Interview." (Information Sheet A-4e).
11. Practice with another student: take turns being the interviewer and the applicant. Use the Performance Checklist as a guide.

## SELF-CHECK TEST
## A-4

### Pretest*

1. Prior to an interview, a well-prepared applicant should:
   a. Rely on memory to answer or fill out any questions.
   b. Be prepared to answer questions by composing his/her own questions and answers.
   c. Answer all questions "off the top of the head."

2. For the interview, an applicant should:
   a. Wait for the interviewer to explain what the company's business is.
   b. Not worry about the company and just interest himself/herself in a specific job.
   c. Research the company.

3. In preparation for the interview, an applicant should:
   a. Locate the company prior to the interview.
   b. Leave early enough to find the company on the day of the interview.

4. Appropriate dress for an interview might be:
   a. Blue jeans and a shirt.
   b. Your best dress-up clothes.
   c. Clean, neat clothes appropriate to the company and the job you're applying for.

5. When an interview is scheduled for 10:00 a.m., the applicant should:
   a. Not worry about being ten (10) minutes late.
   b. Be punctual.
   c. Arrive an hour early.

6. When speaking with the interviewer, an applicant should:
   a. Emphasize good points.
   b. Tell the interviewer he/she didn't do so well in some skills or courses.
   c. Avoid the whole truth.

7. To answer any questions an interviewer might ask, an applicant should:
   a. Be honest, factual, and sincere.
   b. Make up something if he/she doesn't know the answer.
   c. Lie if necessary to make a good impression.

8. If asked, "What can you do?" an applicant should:
   a. Avoid saying, "I'll do anything."
   b. Tell the interviewer, "It depends."
   c. Say, "I'll do anything."

Self-Check Test (continued)

9. When speaking to an interviewer, an applicant should:
    a. Try to look the interviewer in the eye.
    b. Read the pre-written paper.
    c. Look around the room.

10. An appropriate response to end an interview might be:
    a. "Thank you."
    b. "See you later."
    c. "Please pick me."

11. If an applicant never hears from the company, he/she should:
    a. Never apply for another job.
    b. Tell friends never to apply there.
    c. Not be discouraged.

12. If an applicant doesn't get the job, he/she should:
    a. Analyze why.
    b. Forget about the interview.
    c. Blame it on the interviewer.

13. If an applicant doesn't get the job, he/she should:
    a. Mourn.
    b. Keep trying.
    c. Be content to be unemployed.

*No answers are provided for this pretest. Instead, use each item as a discussion item with your instructor and class. Also, look for the correct answers as you complete the other Learning Activities for this task.

# Information Sheet A-4

124 Main Street
Charleston, West Virginia 25000
September 10, 19__

Mr. James Polk
Personnel Director
Ace Manufacturing
253 Brownlee Road
Charleston, West Virginia 25003

Dear Mr. Polk:

In response to your ad for Machinists in the Sunday, September 9, 19__, edition of The Charleston Post, I am enclosing a resume.

I have recently completed the two-year machine shop program at John Quincy Adams Vocational Center, where I satisfactorily completed all the required competencies for this program.

My experiences in school and in the custodial position at National Machine and Tool Company will indicate to you that I am very much interested in a career in machining. You will note also that I have had a great deal of leadership experience through VICA, which will indicate both my interest in machining and potential to be an asset to your company.

I would appreciate your consideration of me as a member of your firm. I can be contacted for an interview at 123-4567.

Thank you very much.

Sincerely,

Michael J. Jobseeker

Enclosure

## Information Sheet A-4a

## INTERVIEWING: A SKILL, NOT A MYSTERY*

### I. GETTING READY FOR AN INTERVIEW

1. Figure out what you really want to do. Be specific. Make a list of exactly what you want AND of what you don't want. Look at what you've done in the past--education, summer jobs, hobbies, clubs, etc. Get help from your counselor. You've got to have some idea of what you're after.

2. Learn everything you can about the company. Read any literature you can find to learn about job openings and what they are like, company benefits, etc. Talk to people who work or have worked for the company. The more you know before the interview, the fewer unnecessary questions you'll have to ask--and the interviewer is bound to be impressed if you've "done your homework."

3. Role-play an interview with a friend, taking turns as interviewer and applicant. This way you'll know the routine of an interview and will be more relaxed when it's for real. Talk to others who have been interviewed (by the company you're applying to if possible).

4. Be fair to yourself--be sure the interviewer knows all about you and what you can do. This means learning to fill out job applications correctly. DON'T give incomplete answers. DON'T fill out the application hurriedly--be sure it's neat and written as clearly as you can. Print everything but your signature. You'll do a better job of giving all the information about yourself if you take along your Personal Data Sheet (Resume). (Some companies use an information form similar to the Personal Data Sheet in addition to the job application form.) Take along a competency record that shows the skills you have mastered.

### II. WHAT INTERVIEWERS LOOK FOR

1. An interview is short. The interviewer must learn a lot about you in a very short time. The basic purpose of the interview is to exchange enough information to screen you from a number of other applicants. They have to decide whether the company should talk with you further and keep your name on the applicant list.

Information Sheet A-4a (continued)

2. First impressions will be noted. The interviewer usually makes notes of the first impression, so making a good first impression is an asset to you and to the company you'd like to work for. During the interview, other general traits will also be noted: poise, ability to communicate, social skills, and personality. In short, the interviewer only sees you once and the impression you leave is what the interviewer sees as a general picture of you.

3. An interviewer wants to find out exactly what you think you want and why, what kind of work you're looking for, and how interested you are in that work. Interviewers also look for career goals, drive to accomplish those goals, interest in further education, further training, and such other things as preferred location and your willingness to relocate if necessary.

4. The purpose of telling the interviewer what you've done is to help indicate if your work interests seem to match your talents. Your qualifications will be reviewed: jobs, grades, skill level, special training, hobbies, and extracurricular activities.

5. If you do seem qualified for a certain kind of work, the interviewer has to see if the company has a job area that might match your interests. If so, they'll explain the details of the work and see if you are interested and just how interested.

## III. HOW TO ACT DURING AN INTERVIEW

1. Be yourself. DON'T "act." The only company you are likely to be happy working for is one that likes you just the way you are. Very few people can play roles well enough to fool an interviewer, who has met and talked to a great many people.

2. Don't overdo it. Act professionally and naturally. Be on time! Be friendly, but not too casual. Be courteous. Have your thoughts and questions well organized.

3. Don't be afraid to tell the interviewer all about yourself. Don't answer questions with just a yes or no. Take this opportunity to tell about your goals and strong points. This may alert an interviewer to terrific information about you that didn't show up on the resume. Open up!

Information Sheet A-4a (continued)

4. Tell it like it is. A lie is often an attempt to hide a problem that will only get in the way later. Be completely honest. If you have no interest in a particular kind of work or job, say so. You should be trying to screen the company too.

## IV. WHAT TO EXPECT AFTER AN INTERVIEW

1. Don't expect to be hired on the spot. It's usually not the role of the interviewer to do the hiring. Interviewers only make screening decisions to determine whether the company should talk with an applicant further. By the end of the interview, most companies will try to tell you as clearly as possible what to expect next.

2. Interviewers rarely promise anything, even when they think the applicant is highly qualified. But if they feel you'll be under active consideration, they'll usually indicate that you can expect a second interview or that they'll contact you later.

3. Write to the interviewer after the interview if you're interested. Mention the interviewer's name, time, and date of the original interview, plus important points discussed. If it's a small company, especially, and you haven't heard anything in a week, call back. Sometimes applications get moved to the bottom of the stack. Remind the interviewer of your interest. Keep on learning about the company.

4. If you get a "NO" answer, it's probably because your interests and the company's don't match. Don't worry, just analyze "why." Almost everyone hears a "no" before a job is landed. Look at it as a learning experience: you've learned about interviewing, about your likes, a company's needs, and you've got great experience to go ahead to another company much better suited to you.

*Adapted from "What Students Should Know About Interviewing," General Electric, Educational Communications Programs, Fairfield, CT 06431, 1978.

## Information Sheet A-4b

## SOME FREQUENTLY ASKED QUESTIONS DURING THE INTERVIEW*

1. What are your future vocational plans?
2. In what school activities have you participated?
3. How do you spend your spare time? What are your hobbies?
4. In what type of position are you most interested?
5. Why do you think you might like to work at our company?
6. What jobs have you held? Why did you leave?
7. What course did you like best in school? Least? Why?
8. What do you know about our company?
9. Do you feel that you have received good general training?
10. Why do you feel that you will be successful in your field?
11. What extracurricular offices have you held?
12. What are your ideas on salary?
13. Do you prefer any specific geographic location? Why?
14. How much money do you expect to earn at the age of 20? 35?
15. How did you rank in school?
16. Do you think that your extracurricular activities were worth the time devoted to them?
17. What personal characteristics are necessary for success in your field?
18. What is your father's occupation?
19. Are you looking for a permanent or temporary job?
20. Do you prefer working alone or with others?
21. Can you take instructions without feeling upset?
22. Tell me a story.
23. Are you primarily interested in making money or do you feel that service to your fellowmen is satisfactory pay?
24. Do you live with your parents?
25. Can you get recommendations from previous employers?
26. What interests you about our products and services?
27. Do you feel you have done the best scholastic work of which you are capable?
28. How long do you expect to work?

Information Sheet A-4b

29. Have you ever had any trouble getting along with fellow students?
30. Have you saved any money?
31. Do you have any debts?
32. Do you attend a church?
33. Do you like routine work?
34. What size city do you prefer?
35. What is your major weakness?
36. Will you work hard to get ahead?
37. Are you eager to please?
38. What do you do to get in good physical condition?
39. Have you had serious illnesses or injuries?
40. Are you willing to relocate if the company wishes?
41. What job in the company would you like most to have?
42. Is it difficult for you to get along with people who have different backgrounds and interests than you?
43. Do you use liquor? How much?
44. Should an employer consider your grades? Why?
45. Would you be willing to work overtime? How much?
46. Do you possess any special skills or abilities?
47. What have you done that indicates initiative and a desire to work?
48. You have a complaint about your job or working conditions. How would you handle it?
49. You and a fellow worker are having differences about your jobs. What would you do?
50. You have an idea you feel will help the company. What would you do?

*Courtesy of the Virginia Polytechnic Institute and State University Agriculture Education Department, Blacksburg, Virginia, in cooperation with the Agriculture Education Service, Division of Vocational Education - State Department of Education, Richmond, Virginia.

## Information Sheet A-4c

## THINGS TO REMEMBER AT THE INTERVIEW*

1. Sit up straight.
2. Speak in a quiet, pleasant voice.
3. Try to answer all questions correctly.
4. Never talk about personal problems.
5. Be respectful.
6. Use your best English at all times.
7. Know or write down the questions you wish to ask during the interview.
8. Never smoke or chew gum during the interview.
9. Inquire as to what follow-up procedure is required.
10. School subjects you liked best, extracurricular activities.
11. Your educational plans.
12. Ask some questions about the firm.
13. If you've ever been employed, be able to list employer, name of firm, date employed, address, salary, and reason for leaving.

---

*Courtesy of the Virginia Polytechnic Institute and State University, Agriculture Education Department, Blacksburg, Virginia, in cooperation with the Agriculture Education - State Department of Vocational Education, Richmond, Virginia.

## Information Sheet A-4d

## FACTORS WHICH FREQUENTLY LEAD TO REJECTION DURING THE JOB INTERVIEW

In the 1969 survey by Penn Tech Institute (Pittsburgh, Pennsylvania), the following factors were reported by 153 companies as having led to the rejection of the applicant during the employment interview.

1. Poor personal appearance.
2. Overbearing - overaggressive - conceited "Superiority complex" - "Know-it all."
3. Inability to express himself/herself clearly - poor voice, diction, grammar.
4. Lack of planning for career - no purpose and goals.
5. Lack of confidence and poise - nervousness - ill-at-ease.
6. Lack of interest and enthusiasm - passive, indifferent.
7. Failure to participate in activities.
8. Overemphasis on money - interested only in best dollar offer.
9. Poor scholastic record - just got by.
10. Unwilling to start at the bottom - expects too much too soon.
11. Makes excuses - evasiveness - hedges on unfavorable factors in record.
12. Lack of tact.
13. Lack of maturity.
14. Lack of courtesy, ill-tempered.
15. Condemnation of past employers.
16. Lack of social understanding.
17. Marked dislike for school work.
18. Lack of vitality.
19. Fails to look interviewer in eye.
20. Limpy, fishy hand-shake.
21. Indecision.
22. Loafs during vacations - lakeside pleasures.
23. Unhappy married life.
24. Friction with parents.
25. Sloppy application blank.
26. Merely shopping around.
27. Wants job only for short time.
28. Little sense of humor.
29. Lack of knowledge in field of specialization.
30. Parents make decisions for him/her.
31. No interest in company, or in industry.
32. Emphasis on whom he/she knows.
33. Unwillingness to go where we send him/her.
34. Cynical.
35. Low moral standards.
36. Lazy.
37. Intolerant - strong prejudices.
38. Narrow interests.
39. Spends too much time in movies.
40. Poor handling of personal finances.
41. No interest in community affairs.
42. Inability to take criticism.
43. Lack of appreciation of value of experience.
44. Radical ideas.
45. Late to interview without good reason.
46. Never heard of company.
47. Failure to express appreciation for interviewer's time.
48. Asks no questions about the job.
49. High pressure type.
50. Indefinite response to questions.

## Information Sheet A-4e

### CHECK LIST TO BE USED BEFORE GOING FOR AN INTERVIEW*

| | | Yes | No |
|---|---|---|---|
| 1. | Did I plan ahead for the interview? | _____ | _____ |
| 2. | Am I nervous when I meet people? | _____ | _____ |
| 3. | Do I ask intelligent questions? | _____ | _____ |
| 4. | Do I become tense when asked questions? | _____ | _____ |
| 5. | Am I highly emotional? | _____ | _____ |
| 6. | Do I take pride in my appearance? | _____ | _____ |
| 7. | Do I listen when someone else is talking? | _____ | _____ |
| 8. | Do I look at the speaker? | _____ | _____ |
| 9. | Do I practice good posture? | _____ | _____ |
| 10. | Do I use proper English? | _____ | _____ |
| 11. | Do I think before answering? | _____ | _____ |
| 12. | Do I answer honestly? | _____ | _____ |

---

*Check list courtesy of the Virginia Polytechnic Institute and State University, Agriculture Education Department, Blacksburg, Virginia, in cooperation with the Agriculture Education Service, Division of Vocational Education, State Department of Education, Richmond, Virginia.

# UNIT B

# HUMAN RELATIONS

## Terminal Objectives

Upon completion of the modules in this unit, you will:

- Understand your personality and needs.
- Understand the principles involved in successful work attitudes.
- Be able to influence the behavior of others by successful use of motivating factors.

## Student Competency Sheet

Unit B: HUMAN RELATIONS

Task 1: UNDERSTAND YOURSELF

---

Performance Checklist

1. Analyze yourself (interests, aptitudes, abilities, personality traits).
2. Analyze your needs (personal, financial).
3. Explore possible careers which will match your personal characteristics and your needs.
4. Set a career goal.
5. Establish short term goals that will help you reach your career goal.

Test

Items Needed:
1. Paper
2. Pen or pencil
3. Envelope

Test:
1. Demonstrate that you understand yourself--your personality and needs.
2. Demonstrate that you can relate knowledge of yourself to career plans.

Standard:
1. Your evaluation of your personality traits, as shown by you on the "Personality Rating Sheet"(Information Sheet B-1) will include a plan to improve any traits rated as "Fair," "Poor," or "Very Poor."
2. You will correctly answer ten (10) of the twelve (12) questions on the test for this task.

---

Learning Activities

1. Read pp. 81-94, Succeeding in the World of Work (Kimbrell and Vineyard), McKnight Publishing Co., 1975.

   a. Make a vocabulary list of new words.
   b. Learn what these words mean.
   c. Discuss the meaning of the words with several classmates.

2. Rate your own personality, using the "Personality Rating Sheet" (Information Sheet B-1).

    a. List your personality traits which need improvement (anything not rated as "Good" or "Excellent"). Try to be honest and objective. (Most of us can use some improvement.)
    b. You may discuss your goals with your instructor to get helpful suggestions for improvement of personality traits which may affect your career plans.
    c. Write your plan for improving any areas not rated as "Good" or "Excellent."
    d. Obtain an envelope from your instructor. Place your evaluation in the envelope. It will be placed in your folder. At the end of the semester, get this envelope and rate yourself again. Note the improvements.

3. See and participate in the following units of Job Survival Skills Program:

    a. Unit I, "Introduction"
    b. Unit II, "Education and Training"
    c. Unit IV, "Self-Concept and Employment"

4. Read pages 95-96, Succeeding in the World of Work. Write a separate paper on each of the following words. Tell what the words mean to you and your personality.

    a. Parental pressure, teacher pressure, and peer pressure
    b. Economic resources
    c. Marital status
    d. Chance
    e. Self-concept

5. Submit each of the above papers to your instructor. Discuss them with the instructor.

6. With the help of your instructor and classmates, review the jobs you were interested in (Unit A, Task 1).

    a. Identify the job area for which you are probably best suited.
    b. List areas of your personality you will need to develop in order to perform your chosen job.
    c. Discuss with your instructor and classmates how these personality factors (traits) are important in performing the daily requirements of your chosen job.

7. Use the job(s) you selected in Activity 6 as the first step toward meeting your career goal.

    a. Discuss your career goal with your instructor. Explore your personal needs and the requirements for reaching your goal.

b. Discuss what you can do to
    (1) fulfill these needs and
    (2) meet the requirements of the job you would like to have and to reach your career goal.

8. Take the written test for this task. You may not use references.

## Information Sheet B-1

## SELF-RATING YOUR PERSONALITY

Rate your own personality according to traits which make up your personality. Use the chart below. (You may add others you feel are important.)

### PERSONALITY RATING

| Trait | Excellent | Good | Fair | Poor | Very Poor |
|---|---|---|---|---|---|
| ATTITUDE | | | | | |
| COURTESY | | | | | |
| DEPENDABILITY | | | | | |
| DESIRE TO SUCCEED | | | | | |
| ENTHUSIASM | | | | | |
| FORESIGHT | | | | | |
| FRIENDLINESS | | | | | |
| HEALTH | | | | | |
| HONESTY | | | | | |
| INITIATIVE | | | | | |
| LOYALTY | | | | | |
| MORALITY | | | | | |
| NEATNESS | | | | | |
| OPEN-MINDEDNESS | | | | | |
| PERSONAL APPEARANCE | | | | | |
| PUNCTUALITY | | | | | |
| SELF CONTROL | | | | | |
| SENSE OF HUMOR | | | | | |
| TACT | | | | | |
| USE OF VOICE | | | | | |
| | | | | | |
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# Student Competency Sheet

## Unit B: HUMAN RELATIONS

### Task 2: UNDERSTAND SUCCESSFUL WORK ATTITUDES

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### Performance Checklist

1. Identify personal traits that affect your relationship with others.
2. Analyze how personal traits and attitudes of others affect you.
3. Analyze how your personal traits affect others.
4. Identify and analyze the ways the attitudes of others are influenced by your attitudes, traits, and habits.
5. Make a plan to upgrade your attitudes, traits, and habits.

### Test

Items Needed:
1. Paper
2. Pencil or pen
3. Envelope

Task: Demonstrate your understanding of the principles involved in "successful work attitudes."

Standard:
1. Your instructor will evaluate your role-play performance of positive and negative attitudes. Your performance must show that you understand:
    a. Yourself in a given role.
    b. How your attitude reflects on your relationship with co-workers.
    c. How your attitude reflects on your relationship with your supervisors.
2. On the test for this task, you must answer twelve (12) of the fifteen (15) questions correctly.

---

### Learning Activities

1. Read pages 50-61, Succeeding in the World of Work.

    a. List and define new terms.
    b. Discuss these terms and what they mean to you with your classmates.

2. Take the "5-Minute Timed Test on Following Directions." (Your instructor will supply the test.)

    a. Remember the terms "honesty" and "discipline": do not "clue" another student as to the content of this test.

3. Read and complete Information Sheet B-2, "Personality Rating."

    a. Put your completed rating sheet in an envelope and seal the envelope.
    b. Give the envelope to your instructor to keep until you have completed the activities for this task.

4. See and participate in the following units of Job Survival Skills Program:

    a. Unit VI, "You and Your Supervisor"
    b. Unit VII, "You and Your Co-Workers"
    c. Unit VIII, "Successful Job Behavior"

5. Participate in a class discussion on positive and negative attitudes:

    a. Role-play attitudes which have been identified by the group.
    b. How have the attitudes demonstrated in the role-play situation changed when the actors played the role of a new employee? an elderly person? a handicapped person? a supervisor?
    c. Your instructor will evaluate your performance.

6. Take the written evaluation for this task. You must answer twelve (12) of the fifteen (15) questions correctly.

7. Your instructor will return the envelope which contains your self-rated "Personality Rating."

    a. Review your self-ratings. Rate yourself again. Have the ratings changed?
    b. Discuss with your instructor the ways you can improve your personality traits to be a more effective worker.

## Information Sheet B-2

## UNDERSTAND SUCCESSFUL WORK ATTITUDES

You have read about and discussed traits which make up personality and affect your relationships with others. These traits are very important. Rate your own personality according to the chart below:

### PERSONALITY RATING

| Trait | Excellent | Good | Fair | Poor | Very Poor |
|---|---|---|---|---|---|
| ATTITUDE | | | | | |
| COURTESY | | | | | |
| DEPENDABILITY | | | | | |
| DESIRE TO SUCCEED | | | | | |
| ENTHUSIASM | | | | | |
| FORESIGHT | | | | | |
| FRIENDLINESS | | | | | |
| HEALTH | | | | | |
| HONESTY | | | | | |
| INITIATIVE | | | | | |
| LOYALTY | | | | | |
| MORALITY | | | | | |
| NEATNESS | | | | | |
| OPEN-MINDEDNESS | | | | | |
| PERSONAL APPEARANCE | | | | | |
| PUNCTUALITY | | | | | |
| SELF CONTROL | | | | | |
| SENSE OF HUMOR | | | | | |
| TACT | | | | | |
| USE OF VOICE | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |

## Student Competency Sheet

Unit B: HUMAN RELATIONS

Task 3: USE PRINCIPLES OF HUMAN RELATIONS

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Performance Checklist

1. Make a list of things others do or attitudes they have that annoy you or that you find difficult to deal with.
2. Make a list of things you do or attitudes you may have that might annoy others or make others feel you are difficult to deal with.
3. Make a list of things you find pleasant in others.
4. Make a list of things others have found pleasant in you.
5. Review these lists to identify positive things about yourself that can influence others.
6. Analyze how the things you listed in #5 can affect your career goal.

Test

Items Needed:
1. Paper
2. Pen or pencil
3. Partner

Task: Demonstrate your understanding of:
- a. Some of the motivating factors which cause human beings to behave as they do, and
- b. Ways of influencing others to behave as you would like them to behave.

Standard:
1. Your instructor will evaluate your written and performance demonstrations of how well you understand and can cope with factors which motivate the way people behave.
2. Your instructor will evaluate the written test for this task. You must answer twelve (12) of the fifteen (15) questions correctly.

---

Learning Activities

1. Read pages 104-111, Succeeding in the World of Work.
   - a. List and define new terms.
   - b. Discuss these terms and what they mean to you with your classmates.

2. See and participate in the following units of Job Survival Skills Program:

   a. Unit III, "From Which Point of View"
   b. Unit V, "Communication"
   c. Unit XIV, "Summarizing"
   d. Unit XV, "Individual Assessment"

3. Write a paragraph discussing why human relationships are important to your career. Have your instructor evaluate your work.

4. With a fellow student, role-play a situation between a new employee and a supervisor or an experienced machinist.

   a. Have your instructor evaluate your behavior during the performance.
   b. Have your classmates discuss their reactions to your performance.

5. Using the same student partner as in Learning Activity 4, describe in writing what message this person's body language conveyed to you during your demonstration.

   a. Discuss your findings with your partner.

6. While you are in laboratory (shop) sessions, your instructor will evaluate your progress. Look at the "Performance Appraisal" example (Information Sheet B-3). Each area of your performance is rated: skill competence and personal effectiveness (how your actions affect others).

   a. Discuss with your classmates how you can try to achieve personality performance skills that will help you earn the best ratings for each item on the form.

7. Take the written evaluation for this task. You must answer twelve (12) of the fifteen (15) questions correctly. (You may not use references.)

## INFORMATION SHEET B-3

## PERFORMANCE APPRAISAL

Name:______________________________ Date:________________

INSTRUCTIONS: This form should be used to evaluate employee performance. It should be reviewed with the employee. Place a check in the space which best expresses your judgment.

| | | | | |
|---|---|---|---|---|
| 1. | QUALITY OF WORK | Unsatisfactory<br>( ) | Satisfactory<br>( ) | Above Average<br>( ) |
| 2. | QUANTITY OF WORK | Substandard<br>( ) | Average<br>( ) | High<br>( ) |
| 3. | POTENTIAL | Doubtful<br>( ) | Promising<br>( ) | Above Average<br>( ) |
| 4. | ATTITUDE | Indifferent<br>( ) | Normal Interest<br>( ) | Enthusiastic<br>( ) |
| 5. | COOPERATION WITH OTHERS | Antagonistic<br>( ) | Satisfactory<br>( ) | Supportive<br>( ) |
| 6. | JOB SKILL | Low<br>( ) | Adequate<br>( ) | Good<br>( ) |
| 7. | INITIATIVE | Needs Prodding<br>( ) | Does Assigned Work Well<br>( ) | Seeks Tasks to be done<br>( ) |
| 8. | ATTENDANCE | Unsatisfactory<br>( ) | Satisfactory<br>( ) | No. of days present<br>( ) |
| 9. | APPEARANCE | Must Improve<br>( ) | Satisfactory<br>( ) | Outstanding<br>( ) |

COMMENTS____________________________________________

____________________________________________________

____________________________________________________

SIGNATURE OF IMMEDIATE SUPERVISOR________________ DATE____________

SIGNATURE OF EMPLOYEE RATED______________________ DATE____________

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# UNIT C

# SAFETY

## Terminal Objectives

Upon completion of the modules in this unit, you will know and practice the basic procedures that will:

- Maintain personal safety
- Maintain general shop safety

## Student Competency Sheet

Unit C: SAFETY

Task 1: MAINTAIN PERSONAL SAFETY

---

Performance Checklist

1. Interpret local, state, and federal safety rules and regulations for machinists.
2. Interpret federal safety color codes.
3. Identify potential safety hazards in your environment.
4. Locate fire extinguishers, first aid station, emergency exits, emergency stops, and other emergency safety features in your environment.
5. Practice personal safety precautions (clothing, work habits, etc.).
6. Locate emergency services (nurse, ambulance, fire company, etc.).
7. Practice correct "do's" and avoid the "don't's" for emergency situations (injury, heart attack, fire, etc.).

Test

Items Needed:

1. Notebook
2. Pencil
3. Local, state, and federal safety code books
4. Floor plans of school
5. Floor plan of shop, showing work stations and emergency/evacuation features
6. Soap and water
7. Safety glasses, goggles, face shields, safe clothing, safety equipment

Task:

1. Demonstrate knowledge of safety rules.
2. Demonstrate knowledge of safety precautions.
3. Demonstrate knowledge of emergency behavior.

Standard:

1. Correctly identify colors and applications designated by federal safety code.
2. Dress and grooming will promote safety.
3. Behavior will promote safety of self and others.
4. Correctly identify safety-emergency features of the shop.
5. Emergency procedures demonstrated are appropriate to the situation.

---

## Learning Activities

1. Start a Safety Notebook. Take daily notes; enter them in sections marked:
    a. Safety Codes
    b. Personal Safety
    c. General Shop Safety
    d. Emergency Procedures
    e, f, etc. To be added according to instructor's directions.
2. Read Machining Fundamentals (Walker), pp. 25-27.
3. With your class, review local, state, and federal safety rules/ regulations. Discuss:
    a. How they are applied in your school.
    b. How they affect local machinists and the companies they work for.
    c. Why they were developed; by whom; when.
    d. Penalties for not complying with regulations.
4. With your instructor, tour your school to identify emergency features:
    a. Locate nurse's station, emergency exits, telephones, fire extinguishers, etc.
    b. Mark and label the sites you identified on a floor plan of the school.
    c. Learn and practice the school's emergency evacuation procedures.
5. With your instructor, tour your shop:
    a. Locate:
        (1) Hazardous areas/equipment
        (2) Safe paths, safety features
        (3) Emergency paths and exits
    b. Identify and, if applicable, practice using items which are color-coded for safety.
    c. Discuss dangerous areas.
    d. Discuss dangerous shop practices.
6. Attend a lecture-demonstration on personal grooming.
    a. Discuss how grooming is related to safety.
    b. Practice the proper technique for washing with soap and water.
7. Attend a lecture-demonstration on:
    a. Appropriate clothing.
    b. Use and care of safety goggles, glasses, and face shields.
    c. Use and care of other safety equipment.

8. Demonstrate proper care and use of clothing and safety equipment.

9. Discuss how personal behavior in the shop/on the job affects your safety and that of others.

10. Invite the school nurse or a paramedic to speak to the class and to demonstrate emergency care and behavior.

    a. Practice the procedures demonstrated.
    b. Discuss situations where these procedures might be helpful; i.e., common shop accidents, heart failure, etc.

11. Write a plan for personal safety.

    a. Have your instructor check your plan.
    b. Compare your plan with those of other class members.

## Student Competency Sheet

Unit C: SAFETY

Task 2: MAINTAIN GENERAL SHOP SAFETY

---

Performance Checklist

1. Interpret local, state, and federal safety rules and regulations for the machine shop.
2. Interpret federal safety color codes.
3. Identify potential safety hazards in your environment.
4. Follow all general shop safety rules.
5. Follow all safety rules specific to your shop.
6. Maintain clean, orderly work area.
7. Identify type of emergency, should one occur; follow emergency plan.

Test

Items Needed:
1. Safety Notebook
2. Pencil
3. Local, state, and federal safety code books
4. Floor plan of shop
5. Fire extinguishers
6. OSHA "Safety and Health Standards Digest"
7. Written emergency procedure for shop

Task: Maintain safe working conditions in the shop.

Standard:
1. Maintain clean, neat work area.
2. Identify guards and safety devices.
3. Identify and operate disconnect switches/ power plugs.
4. Identify cause of fire and use correct extinguishing method.
5. Follow shop procedures for reporting accidents, faulty equipment, or other abnormal shop situations.

---

Learning Activities

1. Read or review Machining Fundamentals (Walker), pp. 25-27.

2. Attend a lecture-demonstration on what contributes to unsafe conditions in the shop. Discuss:

a. Cleanliness
b. How personal working habits affect general shop safety.
c. How alertness affects general shop safety.
d. Local, state, and federal regulations that must be followed.
e. Classroom rules that must be followed.

3. Discuss the intent and coverage of OSHA. Then,

   a. Read the "OSHA Safety and Health Standards Digest," if available, or read wall charts.
   b. Locate items or areas of your classroom that are specifically referenced in OSHA guidelines.

4. Tour the classroom with the instructor. Discuss:

   a. Traffic lanes and clearance zones.
   b. Maintenance of storage areas.
   c. Equipment operation.
   d. Potentially hazardous areas and equipment.
   e. Why equipment may be used only under the supervision of the instructor.

5. Make a list of the metalworking stations in the shop:

   a. List the kinds of equipment in each different kind of work station.
   b. List the safety features for each of the kinds of equipment; i.e., location of stop switches, exhaust fans, guards, etc.
   c. Color code your list with the appropriate federal safety color coding.
   d. Discuss special safety precautions necessary for each piece of equipment.

6. Attend a lecture-demonstration on the causes of fire and on extinguishing fires:

   a. List the kind of equipment/materials that would be necessary to extinguish fires.
   b. Locate the fire extinguishers in your shop.
   c. Demonstrate the operation of the types of fire extinguishers in the shop.

7. With the class, make an emergency plan for your shop.

   a. Compare the class plan with the existing school plan.
   b. If you are unclear of any of the steps, discuss them with the instructor.

8. Rehearse the emergency plan for your shop. Role-play several situations: fire, injuries, heart failure due to electrical shock, etc.

# UNIT D

## BASIC MATHEMTAICS

### Terminal Objectives

Upon completion of the modules in this unit, you will:

- Compute whole numbers
- Compute common fractions
- Compute decimal fractions
- Calculate/express percentages, averages, and estimates
- Use basic measuring tools

## Student Competency Sheet

Unit D: BASIC MATHEMATICS

Task 1: COMPUTE WHOLE NUMBERS

---

Performance Checklist

1. Convert written numbers to Arabic numerals.
2. Add whole numbers to find the sum:
   a. Write one number under another so the unit digits are in the units column, tens in the tens column, etc.
   b. Add all the numbers in the units column.
   c. Write the unit digit at the bottom of the column. If a column sum is more than 9, put the second digit at the top of the next column to the left.
   d. Add the numbers in the tens column. Write the last digit in this sum in the tens column. If the sum is greater than 9, put the second digit at the top of the hundreds column.
   e. Continue to add each column of numbers in the same manner.
   f. Check for accuracy by adding from bottom to top of columns.
3. Subtract whole numbers to find the difference (remainder).
   a. Write the larger of the two (2) numbers (the minuend).
   b. Write the number to be subtracted (subtrahend) directly below the minuend. All digits must be in the respective columns (unit below unit, ten below ten, etc.).
   c. Start with the units column; subtract the number in the subtrahend (lower number) from the minuend (number at the top).
   d. Continue in the same manner with the tens, hundreds, etc., to compute the difference.
   e. Check for accuracy by adding the subtrahend and the difference.
4. Multiply whole numbers to find the product.
   a. Write the larger of the two (2) numbers as the multiplicand. Below it, write the multiplier (the smaller of the two (2) numbers) so that the units, tens, hundreds, etc., values are in the same columns.
   b. Multiply the numbers in the units column. Write the result in the units column and carry over the tens to the tens column.
   c. Multiply the number in the tens column of the multiplicand (top number) by the number in the units column of the multiplier (lower number). Add the tens remainder (carried over from the units column) to this product.
   d. Write the first digit on the right (i.e., the "9" if the number is "19") in the tens column.
   e. Carry over any numerals representing hundreds; add to the next product. (If no other numbers are to be multiplied, write each digit result in the proper column.)
   f. Continue to multiply every number in the multiplicand; write each digit in the result in the proper column, carrying over as needed.

   g. Add the results in each column.
   h. Check for accuracy: write the multiplicand as the multiplier; the multiplier as the multiplicand (i.e., reverse the top and bottom numbers of the original problem). Multiply again (rework) and check the product with the original product.

5. Divide whole numbers to find the quotient.
   a. Write the number to be divided as the dividend, inside the division frame. Write the divisor (number to be divided into the dividend) to the left of the dividend, but outside the frame.
   b. Determine (estimate) how many times the numerals in the first few digits (left to right) of the dividend may be divided by the divisor. (This is the "trial quotient.") Write it over the units column of the dividend (in the line formed by the top of the frame).
   c. Test your estimate: multiply the divisor by the trial quotient, units first, the tens, etc. Place the product under the dividend.
   d. Subtract the product from the dividend; write the difference in the columns below the units, ten, etc., of the numbers just calculated.
   e. Copy (bring down) the numeral in the next place (to the right of the numbers just used) in the dividend. If the remainder cannot be divided by the divisor, bring down the next numeral in the dividend.
   f. Repeat the division process until all numerals in the dividend are used. When the divisor does not divide evenly into the dividend, the number left over after the last subtraction is the remainder.

## Test

Items Needed:
1. Paper
2. Pencil
3. Practice sheets
4. Ruler or steel tape

Task: Add, subtract, multiply, and divide whole numbers.

Standard: Computation of sums/differences/products/quotients must be at least 95% accurate in each of the operations.

---

## Learning Activities

1. Read Basic Mathematics Simplified (Olivo/Olivo), pp. 1-6.

   a. Watch a demonstration by your instructor.
   b. Complete the Assignment Unit of the unit you read.

   c. If your instructor provides you with additional problems, complete them.
   d. Have your instructor check your work.

2. Read Basic Mathematics Simplified, pp. 7-10.

   a. Watch a demonstration by your instructor.
   b. Complete the Assignment Unit of the unit you read.
   c. Complete any practice sheets provided by your instructor.
   d. Have your instructor check your work.

3. Read Basic Mathematics Simplified, pp. 11-15.

   a. Watch a demonstration by your instructor.
   b. Complete the Assignment Unit of the unit you read.
   c. Complete any practice sheets provided by your instructor.
   d. Have your instructor check your work.

4. Read Basic Mathematics Simplified, pp. 16-19.

   a. Watch a demonstration by your instructor.
   b. Complete the Assignment Unit of the unit you read.
   c. Complete any practice sheets provided by your instructor.
   d. Have your instructor check your work.

5. Make up your own problems in each of the four operations (addition, subtraction, multiplication, division).

   a. Compute the answers without using a calculator.
   b. Have a partner compute the answers.
   c. Do the problems written by your partner.

   (Suggested activity for developing problems: measure several items in the shop area to the nearest whole number; for example, the classroom, windows, pipe or wire, a stack of books.)

6. Take the "Achievement Review for Whole Numbers," pp. 20-22, Basic Mathematics Simplified, or another test supplied by your instructor.

   a. Your instructor will evaluate your work.
   b. Discuss problem areas with your instructor.
   c. Set up a schedule for completing additional assignments in any of the operations where you and your instructor feel you need a stronger background.

## Student Competency Sheet

Unit D: BASIC MATHEMATICS

Task 2: COMPUTE COMMON FRACTIONS

---

Performance Checklist

1. Demonstrate understanding of the concept, interpretation, and use of common fractions.
2. Reduce fractions to lowest common denominator (lowest terms).
    a. Proper fractions: divide the numerator (above the line) and the denominator (below the line) by the same number. (Reduce to lowest terms.)
    b. Improper fractions: divide the numerator by the denominator. (Reduce to lowest terms.)
3. Add common fractions.
    a. Change all fractions to be added to fractions having a least common denominator.
    b. Add the numerators.
    c. Write the sum over the common denominator.
    d. Reduce the sum to its lowest terms.
    e. If adding whole numbers, mixed numbers, and common fractions:
        (1) Add the whole numbers.
        (2) Add the fractions.
        (3) Add the two sums.
        (4) Reduce the result to lowest terms.
4. Subtract common fractions.
    a. Subtract proper fractions:
        (1) Use the lowest common denominator to express all fractions.
        (2) Subtract the numerators.
        (3) Write the difference over the lowest common denominator.
        (4) Reduce the resulting fraction to lowest terms.
    b. Subtract a fraction from a whole number:
        (1) Take one unit from the whole number; change into a fraction which has the same denominator as the fraction which is to be subtracted.
        (2) Subtract the numerators of the original fraction from the unit that was changed to a fractional value.
        (3) Express the resulting fraction in lowest terms.
        (4) Place the whole number next to the left of the fraction.
    c. Subtract a mixed number from a whole number:
        (1) Borrow a unit from the whole number; express it as a fraction which has the same denominator as the mixed number.
        (2) Subtract the fraction part of the mixed number from the fraction part of the whole number.

        (3) Subtract the whole numbers and reduce the resulting mixed number to its lowest terms.
    d. Subtract mixed numbers from mixed numbers:
        (1) Use the least common denominator to express the fractional part of each mixed number.
        (2) Borrow one unit, when necessary, to make up a fraction that is larger than the one to be subtracted.
        (3) Subtract the fractions first, the whole numbers next. Express the results (difference) in lowest terms.

5. Multiply common fractions.
    a. Multiply two (2) or more fractions:
        (1) Multiply the numerators.
        (2) Multiply the denominators.
        (3) Write the product of the numerators over the product of the denominators.
        (4) Express the product fraction in lowest terms.
    b. Multiply a common fraction by a mixed number:
        (1) Express the mixed number as an improper fraction where the numerator is larger than the denominator.
        (2) Multiply the numerator of the improper fraction by the numerator of the common fraction.
        (3) Multiply the denominators.
    c. Multiply fractions, whole numbers, and mixed numbers:
        (1) Express all mixed numbers as improper fractions.
        (2) Place all whole numbers over a denominator of 1.
        (3) Multiply all numerators.
        (4) Multiply all denominators.
        (5) Express product in lowest terms.
6. Divide common fractions.
    a. Divide fractions:
        (1) Invert the divisor (turn the fraction upside down so the denominator becomes the numerator, the numerator becomes the denominator).
        (2) Change the division sign to a multiplication sign; multiply.
    b. Divide fractions and whole numbers:
        (1) Express the whole number as a fraction (write the number over a denominator, which is "1".)
        (2) Invert the divisor.
        (3) Multiply the fractions.
    c. Divide mixed numbers:
        (1) Express mixed numbers as improper fractions.
        (2) Invert the divisor.
        (3) Multiply the fractions.

Test

Items Needed:
1. Pencil
2. Paper
3. Practice sheets
4. Ruler or steel tape

| | |
|---|---|
| Task: | Add, subtract, multiply, and divide common fractions. |
| Standard: | 1. Results must be expressed as least common denominator.<br>2. Computation of sums/differences/products/quotients must be at least 95% accurate in each of the operations. |

---

Learning Activities

1. Read Basic Mathematics Simplified (Olivo/Olivo), pp. 23-28.

2. Attend a lecture-discussion on how common fractions are used in machining and other occupations.

3. Measure objects in the classroom. Write the measurements, using fractions to express parts of an inch, foot, etc.

4. Practice reducing fractions to their lowest terms (the least common denominator), using the measurements you took in Learning Activity 3.

5. Read Basic Mathematics Simplified, pp. 29-32.

   a. Watch a demonstration by your instructor.
   b. Complete the Assignment Unit of the unit you read.
   c. Have your instructor check your work.

6. Read Basic Mathematics Simplified, pp. 33-38.

   a. Watch a demonstration by your instructor.
   b. Complete the Assignment Unit of the unit you read.
   c. Have your instructor check your work.

7. Read Basic Mathematics Simplified, pp. 39-43.

   a. Watch a demonstration by your instructor.
   b. Complete the Assignment Unit of the unit you read.
   c. Have your instructor check your work.

8. Read Basic Mathematics Simplified, pp. 44-48.

   a. Watch a demonstration by your instructor.
   b. Complete the Assignment Unit of the unit you read.
   c. Have your instructor check your work.

9. Make up your own problems in each of the four operations (addition, subtraction, multiplication, and division of fractions).

   a. Compute the answers.
   b. Have a partner compute the answers.
   c. Do the problems written by your partner.

(When writing problems, use the smallest fractional unit commonly expressed for whatever kind of measurement you are using, such as 1/64".)

10. Take the "Achievement Review for Common Fractions," pp. 49-51, Basic Mathematics Simplified, or another test supplied by your instructor.

    a. Your instructor will evaluate your work.
    b. Discuss problem areas with your instructor.
    c. Set up a schedule for completing additional assignments in any of the operations where you and your instructor feel you need a stronger background.

## Student Competency Sheet

Unit D: BASIC MATHEMATICS

Task 3: COMPUTE DECIMAL FRACTIONS

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Performance Checklist

1. Express whole numbers and common fractions as decimal numbers and fractions.
2. Read decimals.
3. Round off decimals.
   a. Determine the degree of accuracy to be expressed. Use the digit in that decimal place unless the digit to its right is 5 or more.
   b. If digit to the right of the digit in the decimal place is 5 or more, increase the digit in the decimal place by one (1).
   c. Drop all other digits that follow.
4. Add decimals.
   a. Write the numbers one under the other so that all decimal points are in a vertical column.
   b. Add each column.
   c. Place the decimal point in the answer directly below the decimal points of the numbers added.
5. Subtract decimals.
   a. Write the numbers so that decimal points are under each other.
   b. Subtract each column of numbers.
   c. Place the decimal point in the answer directly below the decimal points of the numbers subtracted.
6. Multiply decimals.
   a. Multiply the same way as with whole numbers.
   b. Total the number of decimal places to the right of the decimal point in both of the numbers being multiplied.
   c. Locate the decimal point in the answer.
7. Convert percent values to or from decimals.
   a. Change percent to decimal:
      (1) Remove the % sign.
      (2) Place a decimal point two (2) digits to the left of the number.
   b. Change decimal to percent:
      (1) Move the decimal point two (2) places to the right.
      (2) Place "%" after this number.
8. Divide decimals.
   a. Place dividend (number to be divided) inside the division frame.
   b. Place the divisor outside the frame (to the left).
   c. Move the decimal point in the divisor to the right so that it becomes a whole number.

   d. Move the decimal point the same number of places to the right of the dividend. (Add zeroes if the dividend has fewer digits than the divisor.)
   e. Mark the position of the decimal point in the quotient.
   f. Divide as whole numbers. (Place each figure in the quotient directly above the digit involved in the dividend.)
   g. Add zeroes after the decimal point in the dividend if it cannot be divided exactly by the divisor.
   h. Continue to divide until the quotient has as many places as are required.

Test

Items Needed:
1. Pencil
2. Paper
3. Practice sheets
4. Ruler or steel tape

Task: Add, subtract, multiply, and divide decimal fractions.

Standard:
1. Results must be expressed to the decimal unit specified.
2. Computation of sums/differences/products/quotients must be at least 95% accurate in each of the operations.

---

Learning Activities

1. Read Basic Mathematics Simplified (Olivo/Olivo), pp. 52-57.

2. Attend a lecture-discussion on how decimal fractions are used in machining and other occupations. Discuss:

   a. How to interpret the decimal system.
   b. How to write decimal fractions.
   c. How to read decimal fractions.

3. Attend a lecture-demonstration on how to convert fractions to decimals.

   a. Measure objects in the classroom.
   b. Write the measurements, using decimals to express parts measured.
   c. Practice converting fractions to decimals.

4. Complete the Assignment Unit on pp. 55-57. Have your instructor check your work.

5. Read Basic Mathematics Simplified, pp. 58-60 and 61-63.
    a. Watch a demonstration by your instructor.
    b. Complete the Assignment Units of these units.
    c. Have your instructor check your work.

6. Read Basic Mathematics Simplified, pp. 64-68.
    a. Watch a demonstration by your instructor.
    b. Complete the Assignment Unit for the unit you read.
    c. Have your instructor check your work.

7. Read Basic Mathematics Simplified, pp. 69-73.
    a. Watch a demonstration by your instructor.
    b. Complete the Assignment Unit for the unit you read.
    c. Have your instructor check your work.

8. Take the "Achievement Review of Decimal Fractions," pp. 74-76, Basic Mathematics Simplified.
    a. Your instructor will evaluate your work.
    b. Discuss problem areas with your instructor.
    c. Set up a schedule for completing additional assignments in any of the operations where you and your instructor feel you need a stronger background.

## Student Competency Sheet

Unit D: BASIC MATHEMATICS

Task 4: CALCULATE/EXPRESS PERCENTAGES, AVERAGES, AND ESTIMATES

---

Performance Checklist

1. Percentages
    - a. Demonstrate understanding of the concepts and uses of "percents."
    - b. Change whole numbers, common fractions, and decimals to percents.
    - c. Find the percent of a number:
        - (1) Convert the percent to either a fractional or decimal equivalent.
        - (2) Multiply the given number by the fractional or decimal equivalent.
        - (3) Point off the same number of decimal places in the product as there are in the multiplier and multiplicand.
        - (4) Label the answer with the appropriate unit of measure.
    - d. Find percentage from base and rate:
        - (1) Write the formula P=BxR (Percentage = Base x Rate).
        - (2) Substitute the given values for the B and R (change the given percent to its decimal equivalent).
        - (3) Multiply.
        - (4) Check for accuracy: substitute the answer for P and rework to see that quantities on both sides of the = sign are equal.
2. Averages
    - a. Demonstrate understanding of the concept and uses of "averages."
    - b. Calculate averages from given values:
        - (1) Check the units of measure in each quantity to be sure they are the same.
        - (2) Arrange the quantities in a column; add.
        - (3) Divide the sum by the number of quantities to get the average.
    - c. Determine values from averages:
        - (1) Multiply the average by the number of quantities.
        - (2) Add the given quantities.
        - (3) Subtract this sum from the product. The difference is the missing value.
3. Estimating
    - a. Demonstrate understanding of the concept and uses of "estimating."
    - b. Estimate to check mathematical accuracy:
        - (1) Work the problem as usual
        - (2) Reread the original problem; determine what numbers can be rounded off.

    - (3) Use these numbers and perform the operations as required.
    - (4) Count off decimal places in the answer very carefully.
    - (5) Check the computed value by comparing the original answer with the estimated value.
- c. Estimate to determine time, costs, materials, or other factors:
    - (1) Collect information and select or compute averages.
    - (2) Perform required mathematical operations; label answers.
    - (3) Total all computations. Rework to check.
    - (4) Round off quantities and amounts; perform mathematical operations.
    - (5) Check the accurate estimate against the rounded-off estimate.

Test

Items Needed:
1. Pencil
2. Paper
3. Practice sheets

Task:
1. Change whole numbers, common fractions, and decimals to percentages.
2. Compute percentage from "base" and "rate."
3. Calculate averages from given values.
4. Calculate values from averages.
5. Estimate to check mathematical accuracy.
6. Estimate to determine time, costs, materials, and other factors of a proposed unit of work.

Standard:
1. Percentage and average answers must be 100% accurate.
2. Estimates may be ± 5% of accurate figures.

---

Learning Activities

1. Read Basic Mathematics Simplified (Olivo/Olivo), pp. 131-135.

2. Attend a lecture-discussion on how "percents" are used in welding, other industries, etc. Discuss:

    a. How to interpret a "percent" statement.
    b. How to express other numbers as percents.

3. Attend a lecture-demonstration on how to:

    a. Find the percent of a number.
    b. Change percents to decimals and fractions.
    c. Practice these procedures.

4. Complete the Assignment Unit on pp. 133-135.
   - a. Have your instructor check your work.
   - b. Discuss anything about which you are unsure.

5. Read Basic Mathematics Simplified, pp. 136-138.
   - a. Watch a demonstration by your instructor.
   - b. Complete the Assignment Unit for the unit you read.
   - c. Have your instructor check your work.

6. Read Basic Mathematics Simplified, pp. 139-142.
   - a. Watch a demonstration by your instructor.
   - b. Complete the Assignment Unit for the unit you read.

7. Take the "Achievement Review of Percentage and Averages," pp. 143-144, Basic Mathematics Simplified.
   - a. Your instructor will evaluate your work.
   - b. Discuss problem areas with your instructor.
   - c. Set up a schedule for completing additional assignments in any of the operations where you and your instructor feel you need a stronger background.

## Student Competency Sheet

Unit D: BASIC MATHEMATICS

### Task 5: USE BASIC MEASURING TOOLS

---

Performance Checklist

1. Interpret terms used in measuring.
2. Identify measuring tools.
3. Measure objects.
4. Draw lines and objects.

Test

Items Needed:
1. Steel rule
2. Steel square
3. Steel tape
4. Outside calipers
5. Inside calipers
6. Combination square
7. Protractor
8. Pencil
9. Paper
10. Objects (or pictures of objects) to be measured and drawn

Task: Use basic tools to measure and draw three (3) objects.

Standard:
1. Objects will be measured to the nearest sixteenth of an inch.
2. Lines and objects will be drawn to specified dimensions.

---

Learning Activities

1. Attend a lecture-demonstration on the use of basic measuring terms and tools used by machinists.

2. Read Basic Mathematics Simplified (Olivo/Olivo), pp. 77-123. Complete the Achievement Review on p. 128.

3. Read Practical Problems in Mathematics (Larkin), pp. 55-68. Complete the Review Problems in each unit.

4. Practice using the six basic tools. Use objects or practice sheets provided by your instructor.

   a. Demonstrate the use of each tool.

   b. Discuss where and when to use each tool.
   c. Discuss the consequences of inaccurate measurement.

4. Make a list of definitions commonly used in expressing standard English measurements.

5. Your instructor will provide three (3) objects or pictures of objects:

   a. Measure the objects to the nearest 1/4", 1/8", and 1/16".
   b. Draw the objects to the specified dimensions.

6. Practice converting measured dimensions of an object to a scale drawing. (Your instructor will specify the scale to be used.)

7. Practice converting measured dimensions (using the five (5) basic tools for linear measurement to decimal equivalents).

8. Practice converting decimals to fractions.

9. Draw several circles.

   a. Randomly divide and mark the circles.
   b. Measure and mark the degrees of the angles.

10. Practice measuring angles of objects (or pictures) provided by your instructor.

11. If you are having any problems in reading or computing measurements, ask your instructor to provide additional Learning Activities. One suggested resource is Basic Mathematics Simplified, 4th ed., Section 4 (pp. 77-130).

## Unit I

# MAINTAINING SHOP FACILITIES AND WORK AREAS

## Terminal Objectives

Upon completion of the modules in this unit, you will be able to:

- Dispose of scrap metal, chips or shavings, and trash or waste materials
- Sweep and clean the shop facility
- Perform custodial tasks
- Paint shop facilities
- Inspect a work area for safe working environment
- Inspect work equipment for safe working environment

## Student Competency Sheet

## Unit I: MAINTAINING SHOP FACILITIES AND WORK AREAS

### Module A: Clean up

### Task 1: DISPOSE OF SCRAP METAL, CHIPS OR SHAVINGS, AND TRASH OR WASTE MATERIALS

---

### Performance Checklist

CAUTION: Protective gloves and eye protection will be utilized.

1. Separate reclaimable metals (aluminum, brass, copper, steel).
2. Separate oil-impregnated cloth waste and dispose in appropriate safety container.
3. Separate cloth waste containing cleaning solvent, thinners, and combustible cutting fluids; dispose of in separate safety-approved container to prevent spontaneous combustion and interreaction of chemicals.
4. Place metal scrap, chips, and shavings in a separate container from paper waste.
5. Identify hazardous substances used in metal area (cyanide compounds, lead compound, carbon tetrachloride).
6. Store brooms and brushes in safe position.
7. Store cutting oils, cleaning solvents, lubricants.

### Test

Items Needed:
1. Cleaning materials
2. Cleaning supplies
3. Brushes
4. Labeled containers
5. Brooms

Task: Dispose of scrap metal, chips, shavings, trash, and waste materials.

Standard: All items on the Instructor Check Sheet must be rated satisfactory by your instructor.

---

### Learning Activities

1. Read two (2) of the following:

   a. Machine Shop Workbook Part I (California State Department of Education), pp. 13-15.

b. Machine Tool Metalworking (Feirer/Tatro), pp. 27-30.
c. Machining Fundamentals (Walker), pp. 25-27.
d. Metalwork Technology and Practices (Ludwig/McCarthy), pp. 29-33 and 165-171.

2. Participate in a discussion with instructor:

   a. Proper placement of reclaimable metals
   b. Safety container to be used for:
      (1) Oily waste
      (2) Cloth waste containing cleaning solvents
      (3) Cloth waste containing combustible chemicals
      (4) Metal chips and shavings
      (5) Hazardous substances
   c. Proper safety clothing and practices:
      (1) Eye protection
      (2) Hand protection
      (3) Use of brushes and brooms

   d. Hazardous substances:
      (1) Cyanide compounds
      (2) Lead compounds
      (3) Carbon tetrachloride solvents
      (4) Kerosine
      (5) Naphtha
      (6) Benzine
      (7) Turpentine and mineral spirits

3. In Safety Notebook, write safety practices, both personal and general shop, found in your readings, as well as those given by the instructor during lectures and demonstrations.

   a. List five (5) safety practices.
   b. List five (5) general shop safety practices.

4. Perform task (disposal of waste materials, trash, etc.), to satisfaction of instructor.

(NOTE: Evaluation of your performance of this task will continue throughout the school year.

## INSTRUCTOR CHECK SHEET - DISPOSE OF SCRAP METAL, CHIPS, SHAVING, AND TRASH OR WASTE MATERIAL

| ACTIVITIES | RATING | |
|---|---|---|
| | ACCEPTABLE | NOT ACCEPTABLE |
| 1. Placed reclaimable scrap metal in proper storage area. | | |
| 2. Placed oily waste in safety containers. | | |
| 3. Placed cloth waste containing combustible chemicals in proper safety containers. | | |
| 4. Placed metal chips and shavings in proper container. | | |
| 5. Placed hazardous substances in proper containers. | | |
| 6. Wore correct safety clothing. | | |
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## Student Competency Sheet

Unit I: MAINTAINING SHOP FACILITIES AND WORK AREAS

Module A: Clean up

Task 2: SWEEP AND CLEAN SHOP FACILITY

---

### Performance Checklist

1. Turn off machines.
2. Clean machine.
3. Clean and turn in all tools and equipment.
4. Put oil absorbent on floor and clean all oil, grease, or spilled liquid.
5. Sweep floor.
    a. Pick up and place in proper container all wiping cloths and waste.
    b. Sweep aisle free of metal chips, shavings, or coils.

### Test

Items Needed:
1. Cleaners
2. Brushes
3. Oil absorbents
4. Brooms

Task: Sweep and clean shop facility.

Standard:
1. All Performance Checklist steps must be followed.
2. Your instructor must rate all steps as being satisfactorily performed.

---

### Learning Activities

1. Read:

    a. Metalwork Technology and Practices (Ludwig/McCarthy), pp. 29-33.
    b. General-Industrial Machine Shop (Johnson), pp. 36-40.

2. Observe demonstration by instructor on:

    a. Use of proper safety equipment.
    b. Proper use of broom.
    c. Proper cleaning techniques for:
        (1) Drill press
        (2) Metal lathes

    - (3) Milling machine
    - (4) Shaper
    - (5) Grinder
    - (6) EDM (Electrical Discharge Machine)
    - (7) Work bench areas
  - d. Use of oil absorbents.
  - e. Cleaning and storage of hand tools.
  - f. Location of safety containers for disposal of oily and contaminated cloth waste.
  - g. Proper disposal of waste material.

3. In Safety Notebook, write:

   - a. Five (5) personal safety practices.
   - b. Five (5) general shop safety practices.

4. Sub-divide equipment and floor area among class members; rotate areas so everyone will have the responsibility at least once for each piece of equipment.

5. Perform clean-up assignment to satisfaction of instructor.

NOTE: Evaluation of your performance of this task will continue throughout the school year.

INSTRUCTOR CHECK SHEET - SWEEP AND CLEAN SHOP FACILITY

| ACTIVITIES | RATING | |
|---|---|---|
| | ACCEPTABLE | NOT ACCEPTABLE |
| 1. Attitude and work habits | | |
| 2. Sweeping floor | | |
| 3. Clean drill press | | |
| 4. Clean grinder | | |
| 5, Clean metal lathe | | |
| 6. Clean milling machine | | |
| 7. Clean shaper | | |
| 8. Clean arbor press | | |
| 9. Clean E.D.M. | | |
| 10. Clean work bench | | |
| 11. Proper storage of hand tools | | |
| 12. Proper disposal of waste material | | |
| 13. Proper use of oil absorbent | | |
| | | |

# Student Competency Sheet

Unit I: MAINTAINING SHOP FACILITIES AND WORK AREAS

Module B: Maintenance

Task 1: PERFORM CUSTODIAL TASKS

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## Performance Checklist

1. Select appropriate cleaners for respective cleaning operations.
2. Clean drinking fountain (if applicable).
3. Maintain drinking fountain facility (if applicable).
4. Clean wash basin.
5. Clean soap or hand cleaner dispenser.
6. Replenish soap or hand cleaner.
7. Empty paper towels from container.
8. Replenish paper towels in dispenser or replenish cloth towels (if applicable).
9. Check and clean locker area.
10. Check and clean eye wash equipment.
11. Clean eye safety equipment (if applicable).

## Test

Items Needed:
1. Cleaners
2. Rags
3. Soap
4. Custodial supplies
5. Towel dispenser
6. Trash collection container

Task: Perform custodial tasks listed in performance checklist.

Standard:
1. All Performance Checklist steps must be performed.
2. Your instructor must rate all steps as being satisfactorily performed.

---

## Learning Activities

1. Observe deomonstration by instructor:
   a. Available cleaning agents
   b. Location and refilling of soap dispensers
   c. Location and refilling of paper towel dispenser

    d. Maintain eye wash equipment
    e. Cleaning and maintenance of eye protection equipment

2. Research cleaning agents available at local stores.

    a. Compare chemical composition.
    b. Compare safety warnings.
    c. Compare cleaning ability.

3. Divide custodial tasks among the class; rotate assignments on a weekly basis throughout the school year.

4. Perform clean up assignment to satisfaction of instructor.

NOTE: Evaluation of your performance of this task will continue throughout the school year.

INSTRUCTOR CHECK SHEET - CUSTODIAL TASKS

| ACTIVITIES | RATING | |
|---|---|---|
| | ACCEPTABLE | NOT ACCEPTABLE |
| 1. Clean water fountain. | | |
| 2. Clean wash basin. | | |
| 3. Clean soap dispenser. | | |
| 4. Clean locker area. | | |
| 5. Clean eye safety equipment. | | |
| 6. Clean eye wash unit. | | |
| 7. Replace towels in dispenser. | | |
| 8. Replenish soap supply. | | |
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## Student Competency Sheet

Unit I: MAINTAINING SHOP FACILITIES AND WORK AREAS

Module B: Maintenance

Task 2: PAINT FACILITIES

---

### Performance Checklist

1. Obtain and set up ladders and/or scaffolding (if applicable).
2. Cover floor and equipment in area to be painted.
3. Provide proper ventilation.
4. Wash down and/or scrape surface to be painted.
5. Select undercoating and/or paint.
6. Prepare brushes and/or paint rollers for painting.
7. Paint surface with appropriate number of coats.
8. Cover and/or dispose of used paint containers.
9. Clean brushes and/or paint rollers.
10. Properly dispose of floor and equipment coverings.

### Test

Items Needed:

1. Ladders and/or scaffolding
2. Covering materials
3. Wire brushes
4. Scrapers
5. Cleaners
6. Paint
7. Paint brushes
8. Paint rollers
9. Paint shop facilities
10. Brush cleaner (water or solvent as required)

Task: Paint the shop facilities.

Standard:

1. All steps in the Performance Checklist must be performed.
2. Your instructor must rate your performance as satisfactory on all steps of the Performance Checklist.

---

### Learning Activities

1. Research composition and uses of different types of paint:
    a. Oil base
    b. Latex base
    c. Epoxy base

   d. Enamel
   e. Lacquer
   f. Primers

2. Research or review the OSHA color coding system.

3. Research uses of and care of different types of paint brushes:

   a. Bristle
   b. Nylon
   c. Polyester

4. Observe demonstration by instructor of:

   a. Cleaning surface:
      (1) Wire brush
      (2) Portable surface grinder
      (3) Abrasive cloth
      (4) Scrapers
   b. Applying primer
   c. Applying top coat
   d. Cleaning painting equipment
   e. Working from ladders
   f. Assembling scaffolding
   g. Protecting surrounding area (drop cloths)

5. Discuss with class and instructor:

   a. Types of paints
   b. Types of paint brushes
   c. Working safety practices for:
      (1) Ladders
      (2) Scaffolding
   d. Types of cleaning agents for:
      (1) Surfaces
      (2) Brushes and painting equipment
   e. OSHA color coding
   f. Safety practices:
      (1) Cleaning solvents
      (2) Air ventilation

6. In Safety Notebook, write:

   a. Five (5) personal safety practices.
   b. Five (5) general safety practices.

7. Your instructor will give you a painting assignment. Complete the assignment, then have your instructor evaluate your work on Instructor Check Sheet I-B-2.

INSTRUCTOR CHECK SHEET - JOB ASSIGNMENT - PAINTING FACILITY

| ACTIVITIES | RATING | |
|---|---|---|
| | ACCEPTABLE | NOT ACCEPTABLE |
| 1. Prepared item to be painted: | | |
| a. Scraped surface | | |
| b. Washed with cleaner | | |
| c. Cleaned with abrasive paper | | |
| 2. Prepared surrounding area (drops). | | |
| 3. Selected correct primer. | | |
| 4. Applied primer. | | |
| 5. Selected proper top coat paint. | | |
| 6. Applied top coat. | | |
| 7. Cleaned up paint equipment used. | | |
| 8. Cleaned up surrounding area. | | |
| 9. Disposed of covering (drops) used. | | |
| 10. Disposed of used paint container. | | |
| 11. Cleaned and stored used brushes. | | |
| 12. Stored unused paint. | | |
| 13. Stored unused thinners and cleaners. | | |
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## Student Competency Sheet

Unit I: MAINTAINING SHOP FACILITIES AND WORK AREAS

Module C: Safety

Task 1: INSPECT WORK AREA FOR SAFE WORKING ENVIRONMENT

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### Performance Checklist

1. General environment:
    a. Floor area clean of chips, shavings, and scrap material.
    b. Floor area free of oil spills.
    c. Proper safety containers for waste materials.
    d. Proper/adequate lighting.
    e. Good ventilation.
2. Safety features:
    a. Proper eye safety equipment available.
    b. Guards on belt and drive equipment.
    c. Paint colors comply with OSHA code.
3. Emergency features:
    a. First aid station fully equipped and accessible.
    b. Fire extinguisher in working order and displayed correctly.
    c. Fire blanket accessible; made of wood (not asbestos).
    d. Emergency power cut-off system operable and accessible.
    e. Equipment wired to relay starter system.

### Test

Items Needed:
1. Disposal cans
2. Proper footwear
3. Proper eye protection gear
4. Proper head protection
5. First aid station
6. Fire extinguisher

Task:
1. Inspect the work area for safe working environment.
2. Report unsafe conditions immediately to your instructor.

Standard:
1. All items on the Check List must be inspected and rated safe or unsafe.
2. Your instructor must agree with your ratings of safe and unsafe conditions.
3. All unsafe conditions must be reported to your instructor.

---

Learning Activities

1. Participate in class discussion with instructor:
   - a. Shop cleaning practices
   - b. Lighting
   - c. Ventilation
   - d. OSHA color coding
   - e. Safety equipment:
     - (1) Eye protection
     - (2) First aid station
     - (3) Fire blanket
     - (4) Fire extinguishers
     - (5) Belt guards

2. Observe demonstration by instructor:
   - a. Use of fire extinguisher
   - b. Emergency power cut-off system

3. Inspect shop area using work area safety checklist (Information Sheet I-C-1).

4. Participate in a class discussion of shop safety inspection.

INFORMATION SHEET I-C-1 WORK AREA SAFETY CHECKLIST

| Shop__________Location__________ | SAFE | UNSAFE | NEEDED CORRECTIONS |
|---|---|---|---|
| 1. Floor area | | | |
| 2. Labeled safety waste containers | | | |
| 3. Lighting | | | |
| 4. Ventilation | | | |
| 5. Guards on equipment | | | |
| 6. First aid station | | | |
| 7. Fire extinguisher | | | |
| 8. Fire blanket | | | |
| 9. Emergency cut-off power system | | | |
| 10. Relay starters on equipment | | | |
| 11. Color coding complies with OSHA | | | |
| 12. Other (specify) | | | |
| | | | |
| | | | |

# Student Competency Sheet

## Unit I: MAINTAINING SHOP FACILITY AND WORK AREA

### Module C: Safety

### Task 2: INSPECT WORK EQUIPMENT FOR SAFE WORKING ENVIRONMENT

---

Performance Checklist

1. Equipment:
   a. Clean
   b. In good repair
   c. Adequate lighting
   d. All guards in place and functional
2. Electrical systems:
   a. Relay starters operable
   b. All wiring in compliance with National Electric Code (NEC)
3. Tools:
   a. In good repair
   b. Safely stored
   c. Broken and unsafe tools have been taken out of use
4. Machine Environment:
   a. Clean
   b. Free of scrap material

Test

Items Needed:
1. Machine tools to be inspected
2. Equipment to be inspected
3. Hand tools to be inspected

Task:
1. Inspect equipment and tools for safe working environment.
2. Identify corrective measures for unsafe conditions.
3. Report unsafe conditions immediately to your instructor.

Standard:
1. All items on the checklist must be inspected and rated safe or unsafe.
2. Your instructor must agree with your ratings of safe and unsafe conditions.
3. All unsafe conditions must be reported to your instructor.

---

## Learning Activities

1. Class discussion with instructor:

    a. Clean equipment
    b. Safety guards
    c. Relay starter systems
    d. Proper lighting
    e. Emergency power cut-off systems
    f. National Electric Code

2. As a class, develop an equipment checklist for machines and hand tools (See Information Sheet I-C-2 Sample Checklist Machine Shop).

3. Use equipment safety checklist to inspect equipment in shop.

    NOTE: Evaluation of your performance of this task will continue throughout the school year.

INFORMATION SHEET I-C-2 SAMPLE CHECKLIST - MACHINE SHOP

NAME________________ DATE__________ EQUIPMENT INSPECTED__________

| | SAFE | UNSAFE | NEEDED CORRECTION |
|---|---|---|---|
| 1. Equipment clean | | | |
| 2. Floor area around equipment clear of debris | | | |
| 3. Equipment in good repair | | | |
| 4. Relay starter sytem | | | |
| 5. Guards in place and functional | | | |
| 6. Belt system guards in place | | | |
| 7. Proper lighting | | | |
| 8. Electrical controls functioning correctly | | | |
| | | | |
| Sample Checklist - Hand Tools | | | |
| 1. Tools stored correctly when not in use | | | |
| 2. Tools in good repair | | | |
| 3. Handles in safe condition | | | |
| | | | |

# UNIT II

## PERFORMING MATHEMATICAL CALCULATIONS

### Terminal Objectives

Upon completion of the modules in this unit, you will be able to:

- Take micrometer readings
- Use machining handbooks, charts, and tables to aid in mathematical calculations
- Apply dimensions of parts from blueprints or specifications to job requirements
- Convert to metric measurement
- Calculate tolerances or allowances for proper fits
- Measure stock
- Calculate stock utilization in machine work
- Calculate the amount of material to be removed to obtain correct work limits
- Determine material strength according to standard raw stock sizes
- Test for hardness
- Calculate the conversion of revolutions per minute (RPM) to surface feet per minute (SFPM) for grinder application
- Calculate machine speeds and feeds by formulas
- Calculate change gearing for threading
- Determine the clearance, relief and rake of cutting tools
- Calculate gear blank specifications for indexing

## Student Competency Sheet

Unit II: PERFORMING MATHEMATICAL CALCULATIONS

Module A: Measurement

Task 1: TAKE MICROMETER READINGS

---

Performance Checklist

1. Read blueprint specifications to determine tolerance permitted; i.e., ± 0.001" or ± 0.0001".
2. Select the correct micrometer to be used.
3. Obtain the item to be measured.
4. Measure, using the micrometer.
5. Record reading.

Test

Items Needed:

1. Several pieces of flat stock
2. Several pieces of round stock
3. Several pieces of tubular stock
4. Selected machined item, such as an automotive brake drum
5. External micrometer caliper
6. Internal micrometer caliper
7. Depth micrometer
8. External vernier micrometer caliper
9. Internal telescoping micrometer
10. Depth micrometer
11. Note paper
12. Pencil or pen
13. Job assignment sheet

Task:

1. Use micrometer caliper to measure thickness and/or diameter of the stock, as requested by your instructor.
2. Use vernier micrometer caliper to measure thickness and/or diameter of the stock, as required by your instructor.
3. Record all readings (measurements).

Standard:

1. The recorded dimensions of the stock must be accurate to ± 0.001" when measured with micrometer calipers.
2. The recorded dimensions of the stock must be accurate to ± 0.0001" when measured with vernier micrometer calipers.

---

## Learning Activities

1. Read one (1) of the following:

    a. Machining Fundamentals (Walker), pp. 32-39.
    b. Metalwork Technology and Practices (Ludwig/McCarthy), pp. 75-82.
    c. Machinists Library; Basic Machine Shop (Black), pp. 78-83.

2. Attend a demonstration by instructor on handling and reading:

    a. External micrometer caliper
    b. Internal micrometer caliper
    c. Depth micrometer
    d. External vernier micrometer caliper
    e. Internal telescoping micrometer
    f. Depth micrometer

3. In Terms notebook:

    a. List the parts of the micrometer.
    b. List the uses of the micrometers demonstrated in Learning Activity #2.

4. Attend a lecture-demonstration on taking micrometer readings of flat, round, and tube stock and of machined parts.

5. Practice reading a micrometer. Then;

    a. Complete Work Sheet II-A-1.
    b. Have your instructor check your work.

6. Practice measuring and recording:

    a. Flat stock
    b. Round stock
    c. Tubular stock
    d. Machined parts

7. Obtain flat stock, round stock, and tubular stock from instructor:

    a. Measure stock with micrometers.
    b. Complete Work Sheet II-A-1a.
    c. Have your instructor evaluate your readings.

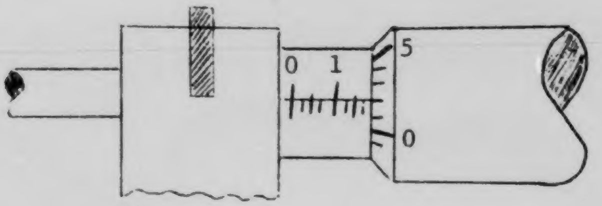
8. Obtain brake drum from instructor:

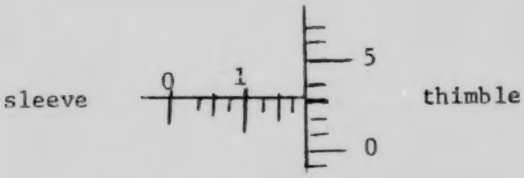
    a. Measure brake drum, using micrometer(s).
    b. Complete Work Sheet II-A-1b.
    c. Have your instructor evaluate your readings.

WORK SHEET II-A-1

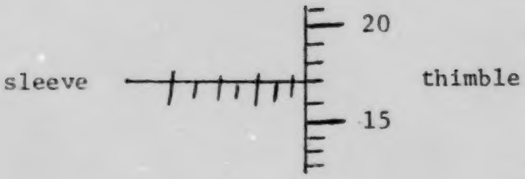
MICROMETER READING

A. Micrometer



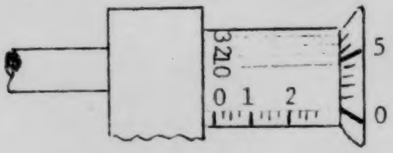

sleeve
0
1
5
0
thimble

Reading____________

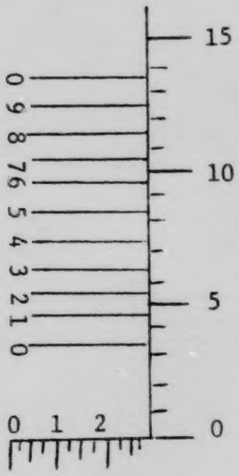

sleeve
20
15
thimble

Reading____________

B. Vernier Micrometer



Reading____________


15
10
5
0
0 9 8 7 6 5 4 3 2 1 0
0 1 2

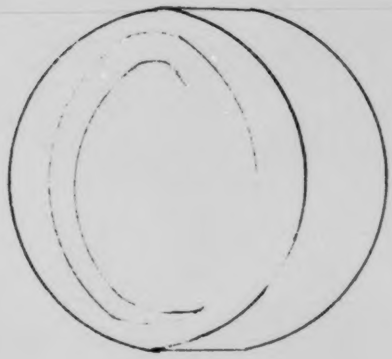
WORK SHEET II-A-1a

## MEASURE STOCK WITH MICROMETER AND RECORD READING

| Stock | Dimensions: Micrometer Caliper | Dimensions: Vernier Micrometer |
|---|---|---|
| Flat Stock | | |
| Sample A | | |
| Sample B | | |
| Sample C | | |
| Round Stock Diameter | | |
| Sample A | | |
| Sample B | | |
| Sample C | | |
| Tubular Stock | | |
| Sample A | | |
| Outside Diameter | | |
| Wall Thickness | | |
| Internal Diameter | | |
| Sample B | | |
| Outside Diameter | | |
| Wall Thickness | | |
| Internal Diameter | | |
| Sample C | | |
| Outside Diameter | | |
| Wall Thickness | | |
| Internal Diameter | | |

WORK SHEET II-A-1b

BRAKE DRUM



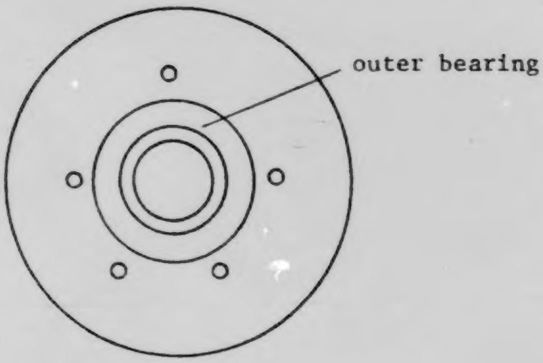
Determine the Following ±0.001:

Internal Diameter_____________

Wall Thickness_______________

Outside Diameter_____________

Depth of Machined
Surface______________________



Determine the Following:

Outside Diameter
of Bearing___________________

Inside Diameter
of Bearing Insert_____________

Depth of Bearing
Insert________________________

## Student Competency Sheet

Unit II: PERFORMING MATHEMATICAL CALCULATIONS

Module A: Measurement

Task 2: USE MACHINING HANDBOOKS, CHARTS, AND TABLES TO AID IN MATHEMATICAL CALCULATIONS

---

### Performance Checklist

1. Identify problem.
2. Select appropriate reference.
3. Locate correct chart, tables, and/or other information in the reference.
4. Obtain all needed information.
5. Calculate using data obtained from reference.

### Test

Items Needed:

1. A mathematical problem assigned by your instructor
2. Machining handbooks
3. Charts
4. Tables
5. Notepaper
6. Pen or pencil

Task: Use handbooks, charts, and tables to make mathematical calculations.

Standard: The solution of the calculations must be accurate according to the references used.

---

### Learning Activities

1. Read one of the following:
   - a. Machining Fundamentals (Walker), pp. 483-504.
   - b. Machine Shop Operations and Setups (Porter/Lascoe/Nelson), pp. 488-509.
2. Read Machinery's Handbook (Oberg/Jones/Horton); compile a list of tables.
3. Research and compile a list of common tables and charts used for reducing calculations.

4. As a class, calculate the following feeds and speeds for high speed drill:

| | RPM Speed | Feed |
|---|---|---|
| Drill diameter 1/2 into cast iron | | |
| Drill diameter 1/4 into brass | | |

5. Obtain and complete practice assignments. Check your work with a partner and your instructor.

6. Your instructor will assign a problem(s).

   a. Obtain necessary references.
   b. Calculate answer(s).
   c. Have your instructor evaluate your work.

# Student Competency Sheet

## Unit II: PERFORMING MATHEMATICAL CALCULATIONS

### Module A: Measurement

### Task 3: APPLY DIMENSIONS OF PARTS FROM BLUEPRINTS OR SPECIFICATIONS TO JOB REQUIREMENTS

---

### Performance Checklist

1. Study blueprint or specification sheet.
2. Select precision measuring equipment.
3. Measure work piece; record readings.
4. Compare work piece readings to blueprint specifications.

### Test

Items Needed:
1. Blueprint
2. Work piece
3. Steel rule
4. Precision measuring instruments
5. Notepaper
6. Pen or pencil

Task:
1. Refer to the blueprint and measure the work piece.
2. Record the measurement.

Standard: An accuracy of ±1/64" is required on length measurement. An accuracy of ±0.002 is required on diameters.

---

### Learning Activities

1. Read:
   a. *Machining Fundamentals* (Walker), pp. 15-24 and 57-66.
   b. *Machinists Library; Basic Machine Shop* (Black), pp. 11-22 and 101-121.
   c. *Metalwork Technology and Practices* (Ludwig/McCarthy), pp. 35-72.
2. Practice using measuring instruments.

3. Obtain a work piece from your instructor:

    a. Sketch work piece.
    b. Measure and mark sketch.
    c. Compare your sketch and measurements to blueprint of work piece.

4. Repeat Learning Activity #3 until you can measure and sketch work piece to instructor's satisfaction.

## Student Competency Sheet

### Unit II: PERFORMING MATHEMATICAL CALCULATIONS

### Module A: Measurement

### Task 4: CONVERT TO METRIC MEASUREMENT

---

**Performance Checklist**

Metric to Standard

1. Select charts and tables.
2. Convert metric measurement to English system linear measurements.

Standard to Metric

1. Select charts and tables.
2. Convert English system linear measurement to metric measurement.

**Test**

Items Needed:
1. English system linear measurement job specifications (provided by your instructor)
2. Machinery's Handbook
3. Notepaper
4. Pen or pencil

Task: Convert the job specifications from the English system of linear measurements to the metric system of measurements.

Standard: All measurements must be accurately converted (to table or chart accuracy).

---

**Learning Activities**

1. Read one (1) of the following:
    a. Basic Mathematics Simplified (Olivo/Olivo), pp. 174-211.
    b. Shop Mathematics (Felker/Bradley), pp. 1-14.
2. Read Machinery's Handbook (Oberg/Jones/Horton), pp. 2412-2440.
3. Attend lecture by instructor:
    a. Reading conversion tables in Machinery's Handbook.
    b. Converting English linear to metric and metric to English linear.

4. Write an explanation for SI metrics.

5. Make a chart of metric to English conversion factors commonly used in the machine shop.

6. Practice conversion of metric to English and English to metric.

7. From your instructor, obtain a set of problems:

    a. Convert English to metric.
    b. Convert metric to English.
    c. Have instructor evaluate your work.

## Student Competency Sheet

## Unit II: PERFORMING MATHEMATICAL CALCULATIONS

### Module A: Measurement

### Task 5: CALCULATE TOLERANCES OR ALLOWANCES FOR PROPER FITS

---

Performance Checklist

1. Determine type of fit.
2. Calculate tolerances.

Test

Items Needed:
1. A type of fit required (as supplied by your instructor)
2. Job specifications (supplied by your instructor)
3. Machinery's Handbook

Task: Calculate tolerance and/or allowance for the specified job.

Standard: Calculations must be accurate to a bilateral tolerance of ± 0.001".

---

Learning Activities

1. Read one (1) of the following:
   a. Machinists Library; Toolmakers Handy Book (Black), pp. 209-220.
   b. Metalwork Technology and Practices (Ludwig/McCarthy), pp. 237-238, 242, 249 and 438.
2. Machinery's Handbook (Oberg/Jones/Horton), pp. 1545, 1581.
3. Attend lecture-demonstration by instructor:
   a. Fits of threads
   b. Expansion fits
   c. Shrinkage fits
   d. USA standard limits and fits
   e. Sliding fits
   f. USA standard interference locational fits
   g. Modified standard fits
   h. British standard for metric ISO limits and fits

4. Define unilateral and bilateral tolerance.

5. Research and write a report on one of the lecture-demonstration topics listed in Learning Activity #3.

6. Practice determining fits, as listed in Learning Activity #3, according to job specifications provided by instructor; calculate the tolerances.

7. Obtain job specifications and type of fit required:

    a. Calculate tolerances.
    b. Have instructor check your work.

## Student Competency Sheet

Unit II: PERFORMING MATHEMATICAL CALCULATION

Module A: Measurement

Task 6: MEASURE STOCK

---

### Performance Checklist

1. Secure and study blueprint.
2. Secure work piece and measuring instrument required.
3. Measure work piece.
4. Record measurements.
5. Compare measurements to blueprint specifications.

### Test

Items Needed:
1. Blueprint
2. Job specifications
3. Work piece
4. Semi-precision/precision measurement instruments

Task:
1. Measure work piece in accordance with Information Sheet II-A-6.
2. Record measurement.

Standard:
1. Measurements must be accurate to the tolerance on the tolerance table (Information Sheet II-A-6)
2. Your instructor must inspect and approve your measurements

---

### Learning Activities

1. Read one (1) of the following:
   - a. Machining Fundamentals (Walker), pp. 29-55.
   - b. Machinists Library; Basic Machine Shop (Black), pp. 47-120.
   - c. Metalwork Technology and Practices (Ludwig/McCarthy), pp. 35-43 and 73-83.
2. Observe lecture-demonstration by instructor:
   - a. Reading blueprints for measurements and tolerances.
   - b. Using precision measuring instruments.

3. Study Information Sheet II-A-6 (Determinants of Measurement Accuracy and Tolerance), then:

    a. Discuss the tolerances given. (To what kinds of work would they most often apply?)
    b. Discuss exceptions to the given tolerances. (On what kinds of work would the exceptions most often be applied?)

4. Practice using measuring instruments and reading blueprints to measure work pieces. Discuss your findings.

5. Obtain job work order and work piece from your instructor:

    a. Study work order for tolerances.
    b. Select required measuring instruments.
    c. Measure work piece and record readings.
    d. Compare readings to blueprint tolerances.
    e. Have instructor evaluate your measuring and interpreting techniques.

INFORMATION SHEET II-A-6

## DETERMINATES OF MEASUREMENT, ACCURACY AND TOLERANCE

| SOURCE/MEASUREMTENT | ACCURACY/TOLERANCE* |
|---|---|
| Blueprint, job specifications | Unless otherwise specified, to blueprint specifications |
| Fractional dimensions | ± 1/64" (unless otherwise specified) |
| Angular dimensions | ± 1/2° (unless otherwise specified) |
| Decimal | ± figure to nearest significant figure (unless otherwise specified)--i.e., example ± 0.001", and ± 0.0001" |

*Source of Accuracy/Tolerance: Machine Tool Technology (W. J. McCarthy and R. E. Smith). McKnight & McKnight, 1968, pp. 49-50.

## Student Competency Sheet

## Unit II: PERFORMING MATHEMATICAL CALCULATIONS

### Module B: Calculating Materials

### Task 1: CALCULATE STOCK UTILIZATION IN MACHINE WORK

---

### Performance Checklist

1. Read bill of materials.
2. Select stock specified to minimize waste, select from:
   a. Scrap pile
   b. Metal racks
3. Size stock to reduce labor.
4. Calculate cost.

### Test

Items Needed:

1. Blueprint (supplied by your instructor)
2. Inventory of stock:
   a. Scrap pile
   b. Metal rack
3. Notepaper
4. Pencil
5. "Bill of Materials" (attached)
6. "Checklist: Stock Utilization" (attached)

Task:

1. Read the blueprint and calculate the stock required to perform the job.
2. Inventory the stock on "Checklist: Stock Utilization."
3. Complete the "Bill of Materials" based upon your calculations and inventory of materials.

Standard:

1. All appropriate spaces on the "Bill of Materials" and "Checklist: Stock Utilization" must be completed.
2. The writing on both forms must be neat and legible.
3. Your instructor must approve your calculations.

---

### Learning Activities

1. Read:

   a. Machining Fundamentals (Walker), pp. 15-24.
   b. Metalwork Technology and Practices (Ludwig/McCarthy, pp. 35-49.

2. Attend lecture-demonstration by instructor:

   a. Maintaining inventory of stock
   b. Calculating cost factors
   c. Reading bill of materials

3. Practice identifying usable stock from scrap pile:

   a. Explain the composition (type of metal and its uses) of each piece.
   b. Write an inventory of the scrap pile.

4. With a partner, examine and discuss the:

   a. Materials in the metal rack supply
   b. Storage/identification system used.

5. Discuss how the correct selection of stock size reduces labor costs. Perform cost analysis using:

   a. Cutting time (estimate time to set up and perform cutting operation)
   b. Current hourly wage rate

6. Study Information Sheet II-B-1 (Bill of Materials and Information Sheet II-B-1a (Checklist: Stock Utilization). Discuss:

   a. The information to be recorded.
   b. Person responsible for supplying information.
   c. Uses of the information.
   d. Importance of accuracy and legible writing (printing).

7. Obtain job work order from instructor:

   a. Write a Bill of Materials from blueprint.
   b. Calculate the cost of materials.
   c. Select materials specified.
   d. Complete a Stock Utilization Checklist (such as Information Sheet II-B-1).
   e. Have your instructor evaluate your work.

INFORMATION SHEET II-B-1 - BILL OF MATERIALS

## BILL OF MATERIALS

JOB ____________________

WORKER ____________________

JOB ORDERED BY ____________________ (DATE)

JOB APPROVED BY ____________________ (DATE)

| PART DESCRIPTION AND IDENTIFICATION NUMBER | NUMBER NEEDED | KIND OF MATERIAL | MATERIAL | |
|---|---|---|---|---|
| | | | SIZE | SHAPE |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
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## INFORMATION SHEET II-B-1a
## CHECKLIST: STOCK UTILIZATION

| BILL OF MATERIALS IDENTIFICATION NUMBER | MATERIAL AVAILABILITY |  |  |  | MATERIAL UTILIZATION* |  |  |  |
|---|---|---|---|---|---|---|---|---|
|  | SCRAP PILE |  | METAL RACK |  | SCRAP WHEN AVAILABLE OVER METAL RACK |  | SIZING TO REDUCE LABOR |  |
|  | YES | NO | YES | NO | YES | NO | YES | NO |
|  |  |  |  |  |  |  |  |  |
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*Use scrap when available over new metal rack supply and correct size selection to reduce labor.

## Student Competency Sheet

### Unit II: PERFORMING MATHEMATICAL CALCULATIONS

### Module B: Calculating Materials

### Task 2: CALCULATE AMOUNT OF MATERIAL TO BE REMOVED TO OBTAIN CORRECT WORK LIMITS

---

**Performance Checklist**

1. Study blueprint.
2. Take measurements of work piece stock.
3. Determine machining technique to be used.
4. Determine amount of material to be removed.

**Test**

Items Needed:
1. Blueprint (provided by your instructor)
2. Notepaper
3. Pen or pencil
4. Work piece stock
5. Measuring instruments

Task: Calculate the amount of material which should be removed to obtain the correct limits for rework.

Standard: Calculations must be accurate according to blueprint specifications.

---

**Learning Activities**

1. Attend lecture-demonstration by instructor:
   - a. Review of reading micrometers and other measuring instruments.
   - b. Review of reading blueprints.
   - c. Calculating material to be removed using:
     - (1) Engine lathe
     - (2) Milling machine
     - (3) Shaper
     - (4) Drill press
2. Practice calculating amount of material to be removed, using several work pieces and blueprints.
3. Obtain job work order from instructor:

a. Obtain blueprint and work piece stock.
b. Measure stock.
c. Calculate difference between stock measurement and blueprint specifications.
d. Determine rough cuts, finish cut depth and rate of speed and feeds.
e. Have your instructor check your calculations.

## Student Competency Sheet

Unit II: PERFORMING MATHEMATICAL CALCULATIONS

Module B: Calculating Materials

Task 3: DETERMINE MATERIAL STRENGTH ACCORDING TO STANDARD RAW STOCK SIZES

---

### Performance Checklist

1. Determine size of stock.
2. Determine type of stock.
3. Calculate strength, using table and charts in Machinery's Handbook.

### Test

Items Needed:

1. Materials of standard stock sizes (provided by your instructor)
2. Table of stock strength
3. Notepaper
4. Pen or pencil
5. Machinery's Handbook

Task: Determine the strength of the material.

Standard: The strength of the material must be determined accurately according to the table.

---

### Learning Activities

1. Read one of the following:
   a. Machining Fundamentals (Walker), pp. 365-376.
   b. Machinists Library; Basic Machine Shop (Black), pp. 121-144.
2. Read Machinery's Handbook (Oberg/Jones/Horton), pp. 358-457 and 2037-2043.
3. Attend lecture-demonstration by instructor:
   a. Using Machinery's Handbook.
   b. Calculating material strength.
4. Practice calculating material strength, using standard stock materials and Machinery's Handbook.

5. Obtain six pieces of material of various standard stock sizes from your instructor:

   a. Using Machinery's Handbook, calculate the strength of each.
   b. Have your instructor evaluate your work.

## Student Competency Sheet

Unit II: PERFORMING MATHEMATICAL CALCULATIONS

Module B: Calculating Materials

Task 4: TEST FOR HARDNESS

---

Performance Checklist

1. Adjust Rockwell Hardness Tester.
2. Apply minor load of 10 kg.
3. Set dial to zero on black figure scale.
4. Apply major load.
5. Remove major load.
6. Take reading while minor load is still applied.
7. Derive hardness number from Scale based on the reading from the test.

Test

Items Needed:
1. One (1) steel sample
2. One (1) unhardened steel sample
3. One (1) soft-temper steel sample
4. One (1) cast iron sample
5. Test blocks with hardness tester
6. Comparative Hardness Scales

Task: Use Rockwell Hardness Test to determine the hardness of the steel and cast iron samples.

Standard:
1. The correct numbers must be taken from the Comparative Hardness Scale, based on the readings resulting from the tests on the sample.
2. Readings taken must agree with the readings taken by your instructor.

---

Learning Activities

1. Read:
    - a. Machining Fundamentals (Walker), pp. 386-392.
    - b. Machinists Library; Basic Machine Shop (Black), pp. 139-143.
    - c. Metalwork Technology and Practices (Ludwig/McCarthy), pp. 455-460.

2. Observe demonstration by instructor on use of:

   a. Rockwell Hardness Tester
   b. Brinell Hardness Tester
   c. Shore Scleroscope Tester
   d. Testing hardness with file.
   e. Care and handling of testers.
   f. Reading Hardness Conversion Table.

3. Write a procedure check list for:

   a. Rockwell Hardness Tester
   b. Brinell Hardness Tester
   c. Shore Scleroscope Tester

4. Determine the hardness of the following, using:

   (1) Rockwell Hardness Tester, (2) Brinell Hardness Tester and
   (3) Shore Scleroscope Tester

   a. Mild steel sample
   b. Low carbon steel sample
   c. Tool steel sample
   d. Cast iron sample

5. Compare readings obtained in Learning Activities #4 with Hardness Conversion Table.

6. Compare your readings with those of other students and the instructor.

# Student Competency Sheet

Unit II: PERFORMING MATHEMATICAL CALCULATIONS

Module C: Calculating Speed

Task 1: CALCULATE CONVERSION OF REVOLUTIONS PER MINUTE (RPM) TO SURFACE FEET PER MINUTE (SFPM) FOR GRINDER APPLICATION

---

## Performance Checklist

1. Note RPM of grinder and diameter of wheel.
2. Calculate surface feet per minute.
3. Determine if wheel is within safety speed operation range.

## Test

Items Needed:

1. Data supplied by your instructor:
   a. Reference or formula
   b. Grinding wheel specifications
   c. Machine specifications (machine operating revolutions per minute (RPM)
2. Notepaper
3. Pen or pencil

Task: Calculate the conversion of revolutions per minute (RPM) to surface feet per minute (SFPM) for the wheel.

Standard: Your answer, rounded off to the decimal point, must be approved by your instructor.

---

## Learning Activities

1. Read:

   a. Shop Mathematics (Felker/Bradley), pp. 126-135 - Teacher Section; Student Section, pp. 223-235.
   b. Metalwork Technology and Practices (Ludwig/McCarthy), p. 408.

2. Read Machinery's Handbook (Oberg/Jones/Horton), pp. 2006-2008.

3. Attend lecture by instructor on calculating conversion of RPM to SFPM.

4. Write an explanation for the following:

   a. $\text{SFPM} = \text{RPM} \times \frac{D}{12} \times \pi$ b. $\text{RPM} = \frac{\text{SFPM} \times 12}{D \times \pi}$

5. Have your instructor check your written work.

## Student Competency Sheet

Unit II: PERFORMING MATHEMATICAL CALCULATIONS

Module C: Calculating Speed

Task 2: CALCULATE MACHINE SPEEDS AND FEEDS BY FORMULAS

---

### Performance Checklist

1. Study blueprint.
2. Determine machining to be done.
3. Determine machines to be utilized.
4. Calculate speeds and feeds.

### Test

Items Needed:

1. Data supplied by your instructor:
    - a. Cutter specifications
    - b. Work piece cutting speed
    - c. Material removal rate
    - d. Reference material
2. Notepaper
3. Pen or pencil

Task:

1. Use formulas and job specifications to calculate machine speed.
2. Round off speed to decimal point.
3. Use formulas and job specifications to calculate machine feed.
4. Round off feed to third place past decimal point.

Standard:

1. Machine speed must be accurately rounded to the decimal point.
2. Machine feed must be calculated to an accuracy of ± 0.001".

---

### Learning Activities

1. Read two (2) of the following:
    - a. Shop Mathematics (Felker/Bradley), Teacher Section, pp. 126-135; Student Section, pp. 223-235.
    - b. Machining Fundamentals (Walker), pp. 106, 152 and 251-253.
    - c. Metalwork Technology and Practices (Ludwig/McCarthy), pp. 214, 465-471 and 548-552.
2. Read Machinery's Handbook (Oberg/Jones/Horton, pp. 1744-1787.

3. Attend lecture demonstration by instructor on calculating feeds and speeds for:

   a. Engine lathe
   b. Grinder
   c. Drill press
   d. Milling machine
   e. Planers

4. Write explanations for:

   $RPM = \frac{CS}{.25S},\qquad RPM = \frac{CS \times 4}{D}$

   $RPM = \frac{FPM \times 12}{\pi D}$

   $Feed = FTR \times T \times RPM$

   $N = \frac{12V}{\pi D}$

   $V = \pi DN/12$

5. Discuss the consequences of incorrect speed/feed calculations in each of the machines listed in Learning Activity #6.

6. Practice calculating speeds and feeds for:

   a. Drill press (to three different sets of specifications).
   b. Surface grinder (to three sets of specifications).
   c. Milling machine (to three sets of specifications).
   d. Engine lathe (to three sets of specifications).
   e. Planers (to three sets of specifications).

7. From your instructor, obtain job specifications and other necessary information to calculate machine speeds and feeds for (one each):

   a. Drill press
   b. Surface grinder
   c. Milling machine
   d. Engine lathe
   e. Planer

8. Have your instructor evaluate your calculations.

## Student Competency Sheet

### Unit II: PERFORMING MATHEMATICAL CALCULATIONS

### Module C: Calculating Speed

### Task 3: CALCULATE CHANGE GEARING FOR THREADING

---

## Performance Checklist

1. Determine lathe screw constant.
2. Determine threads per inch to be cut.
3. Calculate gear change requirements using a formula.

## Test

Items Needed:
1. Machinery's Handbook
2. Blueprint (supplied by your instructor)
3. Specified lathe data
4. Notepaper
5. Pen or pencil

Task: Calculate gear change requirements to cut a given number of threads per inch.

Standard: Calculations must be 100% accurate according to blueprint specifications.

---

## Learning Activities

1. Read one of the following:
   - a. Machinists Library; Basic Machine Shop (Black), pp. 201-207.
   - b. Machinery's Handbook (Oberg/Jones/Horton), pp. 1454-1482.
2. Attend lecture demonstration by instructor:
   - a. Simple gearing.
   - b. Compound gearing.
   - c. Changing lathe gearing.
3. Terms to be defined. (Write in Terms notebook; discuss).
   - a. Even-geared and odd-geared lathe
   - b. Tumbler reverse gears
   - c. Lead Screw
   - d. Edler gear
   - e. Gear train
   - f. Gear ratio
   - g. Lathe screw constant

4. Practice calculating gear ratio's for threading.
5. Calculate gear change requirements to cut a given number of threads per square inch, using six different blueprints supplied by your instructor.
6. Have your instructor evaluate your calculations.

# Student Competency Sheet

## Unit II: PERFORMING MATHEMATICAL CALCULATIONS

### Module D: Calculating for Machine Set-up

### Task 1: DETERMINE CLEARANCE, RELIEF AND RAKE OF CUTTING TOOLS

---

## Performance Checklist

1. Determine from blueprint type of cutter required.
2. Determine material being machined.
3. Obtain, from tables, required angle information.
4. Use protractor head with rule to select pre-ground cutter to match needs.

OR

1. Obtain selection of pre-ground cutting tools.
2. Measure clearance, relief and rake angles.
3. Identify where and on what type material the cutters were ground.

## Test

Items Needed:
1. Blueprint or work order
2. Pre-ground cutting tool
3. Table of cutting angles
4. 6" protractor with rule
5. Notepaper
6. Pen or pencil

Task:
1. Determine cutter clearance.
2. Determine relief of pre-ground cutting tool.
3. Determine rake of pre-ground cutting tool.

Standard: Angular dimensions must be ± 1/2°.

---

## Learning Activities

1. Read one (1) of the following:
    a. Machining Fundamentals (Walker), pp. 146-151.
    b. Machinists Library; Basic Machine Shop (Black), pp. 191-210.
    c. Metalwork Technology and Practices (Ludwig/McCarthy), pp. 474-478.

2. Read Machinery's Handbook (Oberg/Jones/Horton), pp. 1796-1817.

3. Attend lecture-demonstration by instructor:

   a. Shapes, styles and sizes of cutters
   b. Checking cutter angles
   c. Grinding cutters
   d. Selecting cutters and grinder for specific operation

4. Practice using protractor head to check angles.

5. Sketch cutters and lable angles by nomenclature.

6. Select pre-ground bits; determine angles and materials the bits were designed to machine.

7. Obtain a blueprint or job work order from the instructor. Practice selecting the correct pre-ground bits to be used.

8. Write a definition for all the angles listed on the Instructor Check Sheet.

9. Obtain a work order or blueprint from instructor:

   a. Select correct pre-ground cutting tool(s).
   b. Have your instructor evaluate your work.

INSTRUCTOR CHECK SHEET - CLEARANCE, RELIEF AND RAKE OF CUTTING TOOLS

| ACTIVITIES | RATING | |
|---|---|---|
| | ACCEPTABLE | NOT ACCEPTABLE |
| 1. Size to fit equipment being used | | |
| 2. End relief | | |
| 3. Side relief | | |
| 4. Side rake angle | | |
| 5. Back rake angle | | |
| 6. Cutting edge angle | | |
| 7. Side clearance angle | | |
| 8. Front clearance angle | | |
| 9. Lip angle | | |
| | | |
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## Student Competency Sheet

Unit II: PERFORMING MATHEMATICAL CALCULATIONS

Module D: Calculating for Machine Set-up

Task 2: CALCULATE GEAR BLANK SPECIFICATIONS FOR INDEXING

---

### Performance Checklist

1. Determine diametrical pitch, number of teeth, and blank outside diameter.
2. Calculate indexing:
   a. For plain indexing head, or
   b. For compound indexing head

### Test

Items Needed:
1. Gear blank
2. Job specifications supplied by your instructor
3. Reference materials
4. Notepaper
5. Pen or pencil

Task: Calculate gear blank specifications for indexing.

Standard: Calculations must be 100% accurate.

---

### Learning Activities

1. Read one (1) of the following:

   a. Machining Fundamentals (Walker), pp. 256-257, 270-274 and 286.
   b. Machine Shop Operation and Setups (Porter/Lascoe/Nelson), pp. 300-306 and 337-361.

2. Read Machinery's Handbook (Oberg/Jones/Horton), pp. 814, 863, and 1541-1542.

3. Attend lecture-demonstration by instructor:

   a. Calculating divider head settings
   b. Cutting gear teeth on milling machine with divider head

4. Practice calculating divider head settings.

5. Obtain job work order from instructor
    a. Calculate index head settings.
    b. Determine diametrical pitch, number of teeth, and outside diameter.
    c. Have instructor evaluate your work.

# UNIT III

# PERFORMING BENCH WORK

## Terminal Objectives

Upon completion of the modules in this unit, you will be able to:

- Hand sharpen cutting tools with abrasive stones
- Cut materials with hand hacksaws
- Ream holes with hand reamers
- Thread with hand taps and with dies
- Disassemble and assemble parts
- Hone and lap surfaces
- Remove damaged screws and other non-hardened threaded hardware
- Remove and replace a helical coil wire screw thread insert (STI)
- Remove frozen or seized parts
- Remove and install pins and splines

## Student Competency Sheet

Unit III: PERFORMING BENCH WORK

Module A: Sharpening Tools

Task 1: HAND SHARPEN CUTTING TOOLS WITH ABRASIVE STONES

---

### Performance Checklist

1. Select cutter sharpener.
2. Sharpen to specifications (lubricate during sharpening).
3. Inspect cutter.
4. Clean sharpener.

### Test

Items Needed:
1. Job specifications (supplied by your instructor)
2. An assortment of cutting tools
3. Oilstones (hones)
4. Box
5. Slip stones
6. Lubricant

Task: Use abrasive stones to hand sharpen cutting tools to the job specifications.

Standard: Your instructor must rate your performance as satisfactory.

---

### Learning Activities

1. Read one (1) of the following:

    a. Machining Fundamentals (Walker), pp. 121-126.
    b. Metalwork Technology and Practice (Ludwig/McCarthy), pp. 403-419.

2. Read Machinery's Handbook, pp. 2031-2034, 1820-1825.

3. Observe demonstration by instructor:

    a. Using hand grinder
    b. Honing and lapping (See Unit III-C-2.)

4. Write a list of tools that require sharpening.

5. In Safety Notebook, write:

    a. Three (3) personal safety practices.
    b. Three (3) general shop safety practices.

6. Practice setting up cutter-sharpener.

7. Practice sharpening cutting tools.

8. Demonstrate cleaning and care of sharpening equipment.

9. Discuss care and storage of cutting tools.

10. Obtain job work order from instructor:

    a. Select safety equipment.
    b. Research for correct angles of cutter.
    c. Grind to angles.
    d. Hone to finish.
    e. Have your instructor evaluate your work.
    f. Clean up work area.
    g. Have your instructor evaluate your clean-up performance.

# Student Competency Sheet

## Unit III: PERFORMING BENCH WORK

### Module B: Cutting and Reaming

### Task 1: CUT MATERIALS WITH HAND HACKSAWS

---

## Performance Checklist

1. Select correct blade.
2. Mount blade.
3. Secure work piece.
4. Saw work piece to specifications.

## Test

**Items Needed:**

1. Hacksaw blades (18, 24 and 32 pitch)
2. Hacksaw frame
3. Work-holding device
4. Aluminum pipe (with scribed lines)
5. Sheet metal stock (with scribed lines)
6. Job specifications (supplied by your instructor)

**Task:** Use hand hacksaws to cut the stock along scribed lines.

**Standard:**

1. Your instructor will evaluate your performance.
2. All items on the attached Check Sheet must be rated correctly performed.

---

## Learning Activities

1. Read two (2) of the following:
   - a. _Machine Shop Operation and Setups_ (Porter/Lascoe/Nelson), pp. 67-70.
   - b. _Machining Fundamentals_ (Walker), pp. 72-75.
   - c. _Metalwork Technology and Practice_ (Ludwig/McCarthy), pp. 84-89.
2. Observe following demonstrations by instructor:
   - a. Selecting hacksaw blades
   - b. Installing hacksaw blades in frame
   - c. Using a hacksaw
3. In Safety Notebook, write:
   - a. Five (5) personal safety practices.
   - b. Two (2) general shop safety practices.

4. In class notebook, list:
   a. Parts of hacksaw frame.
   b. Common blades and their application.

5. Practice cutting straight line in scrap material with hacksaw.

6. Practice installing blades in frame.

7. Practice the cuts specified on the attached Instructor Check Sheet #1 (Hand Hacksaw).
   a. Select and mount the correct blade.
   b. Secure the work piece.
   c. Cut as indicated on the check sheet.
   d. Have your instructor evaluate each cut.

8. Obtain job specification sheet from instructor; cut stock according to specifications. The instructor will evaluate your work (Instructor Check Sheet #2--Hacksaw Operation Check Sheet).

## INSTRUCTOR CHECK SHEET #1 - HAND HACKSAW

| | RATING | |
|---|---|---|
| ACTIVITIES - Work to be sawed: | ACCEPTABLE | NOT ACCEPTABLE |
| 1. Sheetmetal | | |
| 2. Aluminum Pipe:<br>Right angle cut | | |
| Angular cut | | |
| 3. Band Iron:<br>Right angle cut | | |
| Angular cut | | |
| 4. 1" square steel stock:<br>Right angle cut | | |
| Angular cut | | |
| 5. 1" diameter round steel stock:<br>Right angle cut | | |
| Angular cut | | |
| 6. Silhouette - irregular shape<br>Jeweler's saw | | |
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INSTRUCTOR CHECK SHEET #2 - HACKSAW OPERATION

| WORK TO BE SAWED | BLADE SELECTION | | BLADE MOUNTING | | WORK SECURED | | FINAL CUT TO JOB SPECIFICATIONS | |
|---|---|---|---|---|---|---|---|---|
| | CORRECT | INCORRECT | CORRECT | INCORRECT | CORRECT | INCORRECT | CORRECT | INCORRECT |
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## Student Competency Sheet

Unit III: PERFORMING BENCH WORK

Module B: Cutting and Reaming

Task 2: REAM HOLES WITH HAND REAMERS

---

### Performance Checklist

Hand Reaming:
1. Secure work piece to work-holding device.
2. Select proper reamer.
3. Mount reamer in tap wrench.
4. Lubricate (if applicable) and ream to specifications.

Hand Reaming With Drill Press:
1. See steps 1-3 above: Hand Reaming.
2. Mount lathe center in drill press spindle.
3. Align center to tap wrench.
4. Lubricate (if applicable) and hand ream to specifications.

### Test

Items Needed:
1. Blueprint (supplied by your instructor)
2. Work piece
3. Work-holding device
4. Reamers
5. Tap wrench
6. Lubricant
7. Drill press
8. Lathe center

Task: Hand ream a hole with hand reamers.

Standard: The hole will be hand reamed to a tolerance of +0.0001" to +0.0005".

---

### Learning Activities

1. Read two (2) of the following:
   - a. Machine Shop Operations and Setups (Porter/Lasco/Nelson), pp. 66-67, 113-119, 131-132.
   - b. Machining Fundamentals (Walker), pp. 82-83, 113-114.
   - c. Machinist Library; Basic Machine Shop (Black), pp. 247-259.
   - d. Metalwork Technology and Practices (Ludwig/McCarthy), pp. 220-223.
2. Attend a demonstration by instructor:
   - a. Types of reamers
   - b. Care of reamers
   - c. Use of hand reamers
   - d. Using reamers in drill press

3. Practice using hand reamer.
4. Practice setting up and using a reamer in a drill press.
5. In your Safety Notebook, write:
    a. Five (5) personal safety practices.
    b. Five (5) general shop safety practices.
6. In your class notebook, write:
    a. Type of reamers.
    b. Parts of reamer.
    c. Correct handling and storage procedure for reamers.
7. Obtain work order for a reaming operation:
    a. Obtain material necessary.
    b. Obtain safety equipment.
    c. Set up and have instructor approval before proceeding.
    d. Perform reaming operation (finished work will be within specified tolerances).
    e. Have your instructor evaluate your work.

## Student Competency Sheet

Unit III: PERFORMING BENCH WORK

Module B: Cutting and Reaming

Task 3: THREAD WITH HAND TAPS

---

### Performance Checklist

1. Secure work piece in holding device.
2. Locate hole position and center punch.
3. Select tap drill and drill hole.
4. Select tap and tap wrench.
5. Tap hole (lubricate during tapping operation).
6. Deburr hole, if necessary.
7. Inspect tapped hole to specifications.

### Test

Items Needed:
1. Blueprint
2. Work piece
3. Holding device
4. Lubricant
5. Assortment of drills
6. Center punch
7. Taper tap
8. Plug tap
9. Bottoming taps
10. Tap wrench handle
11. References or tables
12. Square

Task: Drill and tap hole through work piece to blueprint specifications.

Standard: All items on the attached Check Sheet must be rated acceptable by your instructor.

---

### Learning Activities

1. Read two (2) of the following:
   a. Machine Shop Operations and Setups (Porter/Lascoe/Nelson), pp. 59-64.
   b. Machining Fundamentals (Walker), pp. 84-90.
   c. Machinist Library; Basic Machine Shop (Black), pp. 261-277.
   d. Metalwork Technology and Practices (Ludwig/McCarthy), pp. 244-249.

2. Attend demonstration by instructor:
    a. Selecting drill bits for tap
    b. Selecting tap
    c. Tap sizes NC, NF and SAE
    d. Using taper tap
    e. Using plug tap
    f. Using bottom tap
    g. Removing broken tap

3. Practice drilling and using taps.

4. In Safety Notebook, write:
    a. Five (5) personal safety practices.
    b. Two (2) general shop safety practices.

5. In class notebook, write:
    a. Meaning of NF, NC, and SAE.
    b. Notes from demonstrations by instructor.
    c. Cutting fluids available.

6. Obtain work order from instructor:
    a. Obtain safety equipment.
    b. Obtain material specified.
    c. Drill and tap according to specifications.
    d. Have instructor evaluate job, using Instructor Check Sheet.
    e. Clean up area and return tap to storage.

INSTRUCTOR CHECK SHEET - CUT THREADS WITH HAND TAPS

| ACTIVITIES | RATING* | |
|---|---|---|
| | ACCEPTABLE | NOT ACCEPTABLE |
| 1. Secured proper safety equipment. | | |
| 2. Secured work piece in holding device. | | |
| 3. Located hole position. | | |
| 4. Selected proper tap drill. | | |
| 5. Drilled hole. | | |
| 6. Selected appropriate tap and tap wrench. | | |
| 7. Tapped hole. | | |
| 8. Applied lubricant during tapping operation. | | |
| 9. Deburred hole, if needed. | | |
| 10. Checked tapped hole against specifications. | | |
| 11. Tapped hole according to bluepring specifications. | | |

*All activities must be rated acceptable by the instructor.

# Student Competency Sheet

Unit III: PERFORMING BENCH WORK

Module B: Cutting and Reaming

Task 4: THREAD WITH DIES

---

## Performance Checklist

1. Secure work piece in vise.
2. Select die.
3. Mount die in diestock.
4. Bevel the end of the work piece.
5. Square diestock to work piece.
6. Cut threads and lubricate during threading operation.
7. Check threaded work piece to specifications.

## Test

Items Needed:
1. Blueprint
2. Work piece
3. Vise
4. Dies
5. Diestock
6. Cutting oil
7. File
8. Rule

Task: Use dies to thread the work piece to blueprint specifications.

Standard: Length of thread must be ± 1/64" of required length.

---

## Learning Activities

1. Read two (2) of the following:
   - a. Machine Shop Operations and Setups (Porter/Lascoe/Nelson), pp. 65-66.
   - b. Machining Fundamentals (Walker), pp. 84-90.
   - c. Machinists Library; Basic Machine Shop (Black), pp. 279-287.
   - d. Metalwork Technology and Practices (Ludwig/McCarthy), pp. 230-243.

2. Attend demonstration by instructor:

   a. Preparing work for using die
   b. Diestock--shapes and designs
   c. Cutting fluids
   d. Using dies correctly
   e. Storing dies when not in use

3. Practice using die.

4. In class notebook, write:

   a. Notes from demonstrations.
   b. Define solid die, split die, diestock.

5. In Safety Notebook, write:

   a. Five (5) personal safety practices.
   b. Two (2) general shop safety practices.

6. Obtain work order from instructor:

   a. Obtain safety equipment.
   b. Obtain material specified.
   c. Prepare stock for threading.
   d. Thread stock.
   e. Have instructor evaluate job, using Instructor Check Sheet.
   f. Clean up area; return die to storage.

INSTRUCTOR CHECK SHEET - **CUT THREAD WITH HAND DIE**

| ACTIVITIES | RATING* | |
|---|---|---|
| | ACCEPTABLE | NOT ACCEPTABLE |
| 1. Selected proper safety equipment. | | |
| 2. Secured work piece in holding device. | | |
| 3. Beveled top edge. | | |
| 4. Selected appropriate die and diestock. | | |
| 5. Threaded stock. | | |
| 6. Applied lubricant during threading operation. | | |
| 7. Checked threaded shaft against specifications. | | |
| 8. Shaft-threaded according to blueprint. | | |
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*All items must be rated acceptable.

# Student Competency Sheet

## Unit III: PERFORMING BENCH WORK

### Module C: Assembly

### Task 1: DISASSEMBLE AND ASSEMBLE PARTS

---

## Performance Checklist

Disassemble:

1. Cut off electrical power.
2. Obtain repair manual.
3. Determine section(s) to be disassembled and remove fasteners.
4. Disassemble in proper sequence.

Assemble:

1. Replace parts according to specifications and in proper sequence.
2. Replace all fasteners.
3. Make adjustments when necessary.
4. Lubricate to specifications.
5. Test equipment, making necessary adjustments.

## Test

Items Needed:
1. Manufacturer's repair manual or job specifications
2. Parts listed in manual or specifications

Task:
1. Disassemble the parts.
2. Reassemble the parts.

Standard:
1. Disassembly and reassembly must be performed according to manufacturer's manual or job specifications.
2. Your instructor must rate all activities on the attached Check Sheet as acceptable.

---

## Learning Activities

1. Attend lecture-demonstrations on:
    a. Identifying repair-work projects.
    b. Record-keeping (time and materials.)
    c. Preparing, interpreting, and handling of work orders.
    d. Reading and interpreting manufacturer's repair manuals.

2. Examine and discuss commonly used lubricants.

3. Discuss and practice safe testing and adjustment procedures.

4. In Safety Notebook, write:

    a. Five (5) pieces of general safety equipment most likely to be needed.
    b. Five (5) personal safety practices.
    c. Five (5) general shop safety practices.

5. Obtain project to be repaired:

    a. Obtain manufacturer's repair manual.
    b. Select safety equipment.
    c. Disassemble project.
    d. Make necessary repairs.
    e. Replace part according to specifications.
    f. Make adjustments to manufacturer's specifications.
    g. Lubricate to specifications.
    h. Test equipment.
    i. Clean up work area; return tools to storage.

INSTRUCTOR CHECK SHEET - DISASSEMBLE AND ASSEMBLE PARTS

| | RATING* | |
|---|---|---|
| ACTIVITIES: DISASSEMBLY | ACCEPTABLE | NOT ACCEPTABLE |
| 1. Turned off electrical power. | | |
| 2. Obtained correct repair manual. | | |
| 3. Selected correct safety equipment. | | |
| 4. Determined section(s) to be disassembled. | | |
| 5. Removed fasteners that hold piece in place. | | |
| 6. Disassembled in correct sequence. | | |
| | | |
| ACTIVITIES: ASSEMBLY | | |
| 1. Assembled all components in correct sequence. | | |
| 2. Replaced part according to specifications. | | |
| 3. Replaced all fasteners. | | |
| 4. Made necessary adjustments. | | |
| 5. Lubricated to specifications. | | |
| 6. Tested equipment and adjusted if necessary | | |
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*All items must be rated acceptable.

# Student Competency Sheet

## Unit III: PERFORMING BENCH WORK

### Module C: Assembly

### Task 2: HONE AND LAP SURFACES

---

Performance Checklist

1. Secure work piece in work holding device, if applicable.
2. Obtain honing rock, lapping compound, and buffing pad.
3. Hone or lap surface to specifications.
4. Inspect.

Test

| | |
|---|---|
| Items Needed: | 1. Blueprint<br>2. Work piece<br>3. Buffing pad<br>4. Lapping compound<br>5. Honing rock<br>6. Lubricant |
| Task: | 1. Hone the work piece.<br>2. Lap the work piece. |
| Standard: | Work piece will be honed to a tolerance of 0.005" to 0.001". |

---

Learning Activities

1. Read two (2) of the following:
    a. Machine Shop Operations and Setups (Porter/Lascoe/Nelson), pp. 200-201.
    b. Machinists Library; Toolmakers Handy Book (Black), pp. 193-203.
    c. Metalwork Technology and Practices (Ludwig/McCarthy,) pp. 127-128, 414-415.
2. Observe a lecture-demonstration by instructor of:
    a. Honing
    b. Lapping
    c. Lapping compounds
3. In Safety Notebook, write:
    a. Three (3) personal safety practices.
    b. Two (2) general shop safety practices.

4. Research lapping machines and write a report on one (1) unit that is available in your shop.

5. Obtain project to be honed or lapped. (Wheel cylinders, cutter bit, micrometer anvil):

   a. Select safety equipment.
   b. Obtain honing and lapping equipment.
   c. Hone or lap project.
   d. Submit project to instructor for evaluation.
   e. Clean up area; return tools to storage.

6. Compile a list of six (6) items that require lapping or honing.

INSTRUCTOR CHECK SHEET - LAPPING AND HONING

| ACTIVITIES | RATING * | |
|---|---|---|
| | ACCEPTABLE | NOT ACCEPTABLE |
| 1. Selected safety equipment | | |
| 2. Secured work in work holding device. | | |
| 3. Selected lapping or honing equipment. | | |
| 4. Performed lapping process correctly. | | |
| 5. Performed honing process correctly. | | |
| 6. Honed work piece to tolerance of 0.005" to 0.001". | | |
| 7. Cleaned work area and returned tools to proper storage area. | | |
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*All items must be rated acceptable.

# Student Competency Sheet

Unit III: PERFORMING BENCH WORK

Module C: Assembly

Task 3: REMOVE DAMAGED SCREWS AND OTHER NON-HARDENED THREADED HARDWARE

---

## Performance Checklist

1. Secure work piece in work-holding device.
2. Select drill, center punch, and drill hole in damaged part.
3. Place screw extractor in hole.
4. Remove damaged part.
5. Inspect threads in hole (re-tap, if necessary).

## Test

Items Needed:
1. Electric drill
2. Assortment of drills
3. Center punch
4. Chuck key
5. Tap Wrench
6. Taps
7. Screw extractor
8. Work-holding device
9. Work piece with damaged screws

Task: Remove the damaged screws and/or other non-hardened threaded hardware from the work piece.

Standard: The fit of the original tapped hole must be maintained.

---

## Learning Activities

1. Read Metalwork Technology and Practices (Ludwig/McCarthy), p. 248.

2. Attend a demonstration by instructor:

   a. Using screw extractor.
   b. Removing broken screw with extractor.
   c. Drilling procedures for using extractors.
   d. Removing a broken tap with tap extractor.

3. In Safety Notebook, write:

   a. Five (5) personal safety practices.
   b. Three (3) general shop safety practices.

4. Practice using extractors.

5. Obtain a project with a broken screw or bolt:

   a. Obtain safety equipment.
   b. Obtain required drills and extractor.
   c. Drill and extract broken stud.
   d. Re-tap hole if necessary.
   e. Have your instructor evaluate your work, using Instructor Check Sheet.

INSTRUCTOR CHECK SHEET - REMOVING DAMAGED SCREW

| ACTIVITIES | RATING* | |
|---|---|---|
| | ACCEPTABLE | NOT ACCEPTABLE |
| 1. Selected correct safety equipment. | | |
| 2. Secured work piece in holding device. | | |
| 3. Selected proper drills. | | |
| 4. Selected correct extractor. | | |
| 5. Center punched and drilled correctly. | | |
| 6. Used extractor correctly. | | |
| 7. Re-tapped threads. | | |
| 8. Fit of original tapped hole was maintained. | | |
| 9. Cleaned up area and returned tools to correct storage area. | | |
| | | |
| | | |

*All items must be rated acceptable.

## Student Competency Sheet

Unit III: PERFORMING BENCH WORK

Module C: Assembly

Task 4: REMOVE AND REPLACE HELICAL COIL WIRE SCREW THREAD INSERT (STI)

---

### Performance Checklist

1. Secure work piece in work-holding device.
2. Remove worn or damaged helical coil (STI).
3. Select proper tap.
4. Clean or retap threads.
5. Select proper helical coil (STI).
6. Insert helical coil (STI) and check to specifications.

### Test

Items Needed:
1. Tables of taps for helical coil wire screw
2. Assortment of helical coils (STI)
3. Work piece
4. Work piece holding device
5. Pliers
6. Taps
7. Tap wrench
8. Cleaner
9. Helicoil insert tool

Task: Remove and replace helical coils (STI).

Standard: Helical coil wire screw thread insert (STI) must be replaced to table specifications.

---

### Learning Activities

1. Attend a lecture-demonstration by instructor:
   a. Helicoil inserts - Steel thread inserts (STI).
   b. Selecting correct insert.
   c. Selecting correct tap for insert and tap.
   d. Installing insert.
   e. Removing damaged inserts.
2. Write notes from demonstration in class notebook.

3. In Safety Notebook, write:
    - a. Five (5) personal safety practices.
    - b. Three (3) general shop safety practices.

4. Obtain item with damaged internal threads:
    - a. Determine helical coil thread size.
    - b. Obtain safety equipment.
    - c. Tap hole with helical coil insert tap.
    - d. Install helical coil insert with insert tool.
    - e. Have instructor evaluate job, using Instructor Check Sheet.
    - f. Clean up area; return tools to storage.

INSTRUCTOR CHECK SHEET - HELICAL COIL INSERTS

| ACTIVITIES | RATING | |
|---|---|---|
| | ACCEPTABLE | NOT ACCEPTABLE |
| 1. Selected safety equipment. | | |
| 2. Secured work in hold down device. | | |
| 3. Removed damaged helical coil insert. | | |
| 4. Selected correct insert. | | |
| 5. Selected correct insert tap. | | |
| 6. Threaded hole correctly. | | |
| 7. Installed insert correctly. | | |
| 8. Cleaned work area and returned tools to storage. | | |
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## Student Competency Sheet

## Unit III: PERFORMING BENCH WORK

### Module C: Assembly

### Task 5: REMOVE FROZEN OR SEIZED PARTS

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Performance Checklist

1. Determine material to be removed and material part it is being removed from.
2. Select proper removal method:
    a. Drive out part,
    b. Drill out part,
    c. Drill and use screw extractor,
    d. Press out part
2. Remove frozen or seized part.
3. Inspect part for damage.

Test

Items Needed:
1. Machine or piece of equipment with frozen or seized part
2. Portable drill
3. Drill press
4. Drills
5. Press
6. Screw Extractor

Task:
1. Select the proper method to remove the frozen or seized part.
2. Remove the frozen or seized part.

Standard: Your instructor must inspect and approve your work.

---

Learning Activities

1. Attend lecture-demonstrations by instructor:
    a. Use of arbor press.
    b. Use of drill press.
    c. Use of electric hand drill.
    d. Drilling, reaming, boring operation on lathe.
    e. Drilling, reaming, boring operation on milling machine.
    f. Use of tap and screw extractors.
2. Define "frozen" and "seized".

3. Obtain job work order from instructor:
    a. Obtain work piece and analyze best way to proceed.
    b. Select safety equipment required.
    c. Set up equipment.
    d. Perform operation of removing frozen or seized part.
    e. Clean up work area.
    f. Inspect work piece for damage; note damage and required repairs.
    g. Submit work piece to instructor for evaluation.

## Student Competency Sheet

Unit III: PERFORMING BENCH WORK

Module C: Assembly

Task 6: REMOVE AND INSTALL PINS

---

### Performance Checklist

Remove Pin:
1. Select tools to remove pin.
2. Drive out or remove pin.
3. Inspect pin for damage and replace, if necessary.

Remove Damaged Pin:
1. Drill pin out, or
2. Remove pin with screw extractor.
3. Inspect hole for damage.
4. Select replacement pin.

Install Pin:
1. Select appropriate pin.
2. Select installation tools.
3. Line up parts as needed to be held together.
4. Drive in pin.
5. Secure pin as necessary.

### Test

Items Needed:
1. Job specifications
2. Pins
3. Machinery's Handbook
4. Drill
5. Hammer
6. Pliers
7. Screw extractor
8. Pin punches
9. Measurement instruments
10. Work piece
11. Drift punches

Task:
1. Remove taper or straight pin.
2. Remove damaged straight pin.
3. Install taper or straight pin.

Standard:
1. All steps on the Performance Checklist must be followed.
2. Pins must be installed to job specifications.

---

## Learning Activities

1. Read:
    - a. Machining Fundamentals (Walker), pp. 360-361.
    - b. Metalwork Technology and Practices (Ludwig/McCarthy), pp. 279-280.
    - c. Machinery's Handbook (Schubert/Garratt), pp. 1141-1149.
2. Attend lecture-demonstrations by instructor:
    - a. Types of pins used
        - (1) Cotter pins
        - (2) Roll pins
        - (3) Solid taper pins
        - (4) Straight pins
        - (5) Clevis pins
        - (6) Dowel pins
        - (7) Split taper pins
        - (8) Grooved pins
    - b. Function of pins and applications
    - c. Removing undamaged pins
    - d. Removing damaged pins
3. Sketch the pins listed in Learning Activity 3a.
4. Practice removing and installing pins.
5. Obtain job work order from instructor:
    - a. Identify type of pin.
    - b. Select safety equipment and tools needed.
    - c. Remove pin.
    - d. Replace pin.
    - e. Clean up work area.
    - f. Submit work piece to instructor for evaluation.

## Student Competency Sheet

Unit III: PERFORMING BENCH WORK

Module C: Assembly

Task 7: REMOVE DEFECTIVE SPLINES AND REPLACE WITH NEW SPLINES

---

### Performance Checklist

1. Drive out or punch out defective external spline.
2. Inspect and measure internal spline for damage.
3. Select proper replacement external spline.
4. Drive in or press in replacement spline.
5. Check alignments.

### Test

Items Needed:
1. Machinery or equipment
2. Job specifications
3. Punch
4. Press
5. Ball peen hammer
6. Appropriate measurement devices
7. Machinery's Handbook
8. Precision measuring devices

Task:
1. Remove defective spline.
2. Replace with a new spline, according to job specifications.

Standard: The new spline must be aligned to job specifications.

---

### Learning Activities

1. Read Machinery's Handbook (Schubert/Garratt), pp. 1015-1043.

2. Attend lecture-demonstrations by instructor:

   a. Spline applications
   b. Involute splines
   c. Straight-sided splines
   d. Removing and replacing spline fitting
   e. Measuring splines

3. Sketch an involute spline and label parts.

4. Practice replacing spline fittings.

5. Common number of splines are: 4, 6, 10, 16. Write the meaning for each in 2" nominal diameter.

6. Obtain job work order from instructor:

    a. Separate splines and measure.
    b. Compare measurements to tolerance sheets.
    c. Remove and replace damaged part.
    d. Reassemble parts.
    e. Clean up work area.
    f. Have your instructor evaluate your work.

# UNIT IV

## OPERATING PRESSES

### Terminal Objectives

Upon completion of the modules in this unit, you will be able to:

- Inspect arbor presses for safe operational condition
- Clean and lubricate an arbor press
- Clean a hydraulic press
- Select accessories and attachments for press work
- Set up a press and disassemble and assemble parts with a press
- Straighten miscellaneous parts with a press
- Set up and punch materials with a press
- Set up and broach materials with a press

## Student Competency Sheet

Unit IV: OPERATING PRESSES

Module A: Maintenance and Inspection

Task 1: INSPECT ARBOR PRESSES FOR SAFE OPERATIONAL CONDITION

---

### Performance Checklist

1. Inspect gears for signs of excessive wear.
2. Inspect rack for signs of excessive wear.
3. Check bed for cracks.
4. Examine handle for bends.
5. Make recommendation for correction of deficiencies in activities 1-4.
6. Determine whether rack can be raised sufficiently to clear part.
7. Have press inspected or approved by instructor or supervisor.

### Test

Items Needed: 1. Arbor press
2. Safety charts

Task: Before operating arbor press, inspect for safe operational condition.

Standard: All activities on the Instructor Check Sheet must be rated satisfactory by your instructor.

---

### Learning Activities

1. Attend lecture/demonstration by instructor:
   - a. Arbor press inspection
   - b. Arbor press operation
   - c. Arbor press safety practices
2. Research operation and applications of arbor press.
3. Write in Safety Notebook:
   - a. Five (5) personal safety practices
   - b. Three (3) general shop safety practices
4. While your instructor observes, perform inspection of arbor press. All items on the Instructor Check Sheet must be rated acceptable.

## INSTRUCTOR CHECK SHEET - INSPECT ARBOR PRESS FOR SAFE OPERATIONAL CONDITION

| ACTIVITIES | RATING | |
|---|---|---|
| | ACCEPTABLE | NOT ACCEPTABLE |
| 1. Inspected gears for signs of excessive wear. | | |
| 2. Inspected racks for signs of excessive wear. | | |
| 3. Checked bed for cracks. | | |
| 4. Examined handle for bends. | | |
| 5. Make recommendations for correction of all deficiencies identified in 1-4 above. | | |
| 6. Determine whether rack could be raised sufficiently to clear part. | | |
| 7. Had arbor press inspected for approval by inspector or supervisor. | | |
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## Student Competency Sheet

Unit IV: OPERATING PRESSES

Module A: Maintenance and Inspection

Task 2: CLEAN AND LUBRICATE ARBOR PRESS

---

### Performance Checklist

Cleaning

1. Apply cleaning solvent with brush.
2. Remove all oil, grease, chips, and grit from press.
3. Wipe press dry with clean rags.
4. Have press inspected.

Lubricating

1. Determine lubricants to be used.
2. Identify parts to be lubricated.
3. Lubricate parts.

### Test

Items Needed:

1. Rubber gloves
2. Brush
3. Cleaning solvent
4. Cleaning rags
5. Manufacturer's maintenance manual or guide
6. Lubricants
7. Oil can and grease gun

Task:

1. Clean the arbor press.
2. Lubricate the arbor press in accordance with the manufacturer's maintenance manual.

Standard: All activities on the Instructor Check Sheets must be rated by your instructor as satisfactorily performed.

---

### Learning Activities

1. Discuss consequences of improperly cleaned and lubricated equipment.

2. Observe demonstration by instructor of cleaning an arbor press.

3. In Safety Notebook, write:

   a. Three (3) personal safety practices
   b. Three (3) general shop safety practices

4. Perform cleaning operation. Your instructor will evaluate your work on Instructor Check Sheet #1 (Clean Arbor Press).

5. Observe demonstration by instructor of lubricating arbor press.
6. Write up lubrication procedure demonstrated by instructor.
7. Perform lubrication of arbor press. Your instructor will evaluate your work on Instructor Check Sheet #2 (Lubricate Arbor Press).

## INSTRUCTOR CHECK SHEET #1 - CLEAN ARBOR PRESS

| | RATING * | |
|---|---|---|
| ACTIVITIES | ACCEPTABLE | NOT ACCEPTABLE |
| 1. Cleaned gears. | | |
| 2. Lubricated gears. | | |
| 3. Cleaned racks. | | |
| 4. Cleaned bed. | | |
| 5. Cleaned and dried handles. | | |
| 6. Cleaned and stored all jigs and fixtures. | | |
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*All items must be rated acceptable.

INSTRUCTOR CHECK SHEET #2 - LUBRICATE ARBOR PRESS

| ACTIVITIES | RATING* | |
|---|---|---|
| | ACCEPTABLE | NOT ACCEPTABLE |
| 1. Determine proper lubricants to be used. | | |
| 2. Identify all parts to be lubricated. | | |
| 3. Applied lubricants according to procedure suggested in manufacturer's manual. | | |
| 4. Inspected lubricated parts. | | |
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*All items must be rated acceptable.

## Student Competency Sheet

Unit IV: OPERATING PRESSES

Module A: Maintenance and Inspection

Task 3: CLEAN HYDRAULIC PRESS

---

### Performance Checklist

1. Disconnect all electrical power to press.
2. Apply cleaning solvent to working parts of press.
3. Remove all oil, grease, chips, and grit from press.
4. Wipe press dry with clean rags.
5. Have press inspected.

### Test

Items Needed:
1. Rubber gloves
2. Brush
3. Cleaning solvent
4. Cleaning rags
5. Hydraulic press

Task: Clean the hydraulic press.

Standard: All activities on the Instructor Check Sheet must be inspected and rated by your instructor as satisfactorily performed.

---

### Learning Activities

1. Read manufacturer's maintenance manual.

2. Observe demonstration by instructor:

    a. Cleaning and lubricating
    b. Bleeding hydraulic system

3. Perform cleaning and maintenance of hydraulic press. Your instructor will evaluate your work, using the Instructor Check Sheet (Hydraulic Press).

INSTRUCTOR CHECK SHEET - HYDRAULIC PRESS

| | RATING* | |
|---|---|---|
| ACTIVITIES | ACCEPTABLE | NOT ACCEPTABLE |
| 1. Disconnected power before cleaning. | | |
| 2. Cleaned and dried work surfaces. | | |
| 3. Removed oil, grease, chips, and grit. | | |
| 4. Checked hydraulic fluid level. | | |
| 5. Bled hydraulic system. | | |
| 6. Reconnected power. | | |
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*All items must be rated acceptable.

# Student Competency Sheet

## Unit IV: OPERATING PRESSES

### Module A: Maintenance and Inspection

### Task 4: SELECT ACCESSORIES AND ATTACHMENTS FOR PRESS WORK

---

**Performance Checklist**

1. Read press work specifications.
2. Select necessary accessories/attachments and safety equipment.
3. Install accessories and attachments.
4. Position work piece between ram and bed.
5. Align and support work piece.
6. Apply pressure.
7. Perform work operation to specifications.
8. Remove accessories/attachments.
9. Clean up work area; return accessories/attachments to storage.

**Test**

| | |
|---|---|
| Items Needed: | 1. Press<br>2. Blueprint for part(s) to be punched (provided by your instructor)<br>3. Assortment of accessories and attachments |
| Task: | Select correct accessories and attachments for press work according to the blueprint specifications. |
| Standard: | Your instructor must approve your selection of all accessories and attachments. |

---

**Learning Activities**

1. Attend lecture-demonstrations by your instructor on using accessories and attachments for press work.

2. List types of operations that can be performed on an arbor press.

3. Write three (3) personal safety practices in Safety Notebook.

4. Obtain several blueprints requiring press work punching operations.

    a. Determine accessories/attachments required.
    b. Explain your decisions to your instructor.

5. Under the supervision of your instructor, set up for and practice:

    a. Pressing bearings
    b. Straightening shafts
    c. Pressing mandrels

6. Obtain work order from instructor:

    a. Select safety equipment.
    b. Select accessories and attachments.
    c. Set up arbor press.
    d. Have instructor check set up. All Instructor Check Sheet items must be rated acceptable.
    e. Clean up work area.

INSTRUCTOR CHECK SHEET - ARBOR PRESS SET-UP

| | RATING* | |
|---|---|---|
| ACTIVITIES | ACCEPTABLE | NOT ACCEPTABLE |
| 1. Utilized safety equipment. | | |
| 2. Inspected arbor press for safety. | | |
| 3. Supported work piece. | | |
| 4. Aligned work. | | |
| 5. Selected correct attachments or accessories. | | |
| 6. Installed attachments/ accessories correctly. | | |
| 7. Performed dismantling and clean-up operations. | | |
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*All items must be rated acceptable.

## Student Competency Sheet

Unit IV: OPERATING PRESSES

Module B: Setting Up

Task 1: SET UP PRESS AND DISASSEMBLE PARTS WITH PRESSES

---

### Performance Checklist

1. Place and clamp stationary part to table.
2. Align moveable part(s) to ram.
3. Lubricate both parts.
4. Turn on power to press.
5. Lower ram to moveable part.
6. Disassemble according to sequence on blueprint.
7. Apply pressure to moveable part.
8. Check for galling.

### Test

Items Needed:
1. Press
2. Blueprint
3. Assembly drawing
4. Part to be disassembled
5. Lubricant
6. Clamps

Task:
1. Set up press.
2. Follow the sequence on the assembly drawing to disassemble the part with the press.

Standard: The part must be disassembled according to the sequence on the assembly drawing.

---

### Learning Activities

1. Observe demonstrations by instructor:
    - a. Press set-up
    - b. Aligning work
    - c. Pressing to disassemble parts
2. In Safety Notebook, write:
    - a. Three (3) personal safety practices
    - b. Three (3) general safety practices

3. Write a list of ten (10) items that require press for disassembly. Discuss procedures with class and instructor.

4. Practice disassembling parts with press, reversing assembly procedures specified in blueprints. Discuss problems with class and instructor.

5. Obtain job work order from instructor:

   a. Select safety equipment.
   b. Set up equipment and work piece.
   c. Disassemble parts.
   d. Clean up work area.
   e. Have instructor evaluate your work, using the Instructor Check Sheet.

INSTRUCTOR CHECK SHEET - **DISASSEMBLE PARTS ON HYDRAULIC ARBOR PRESS**

| ACTIVITIES | RATING* | |
|---|---|---|
| | ACCEPTABLE | NOT ACCEPTABLE |
| 1. Utilized safety equipment. | | |
| 2. Cleaned and lubricated press. | | |
| 3. Secured work piece to table. | | |
| 4. Aligned work piece to ram. | | |
| 5. Used jigs and attachments correctly. | | |
| 6. Lubricated work piece. | | |
| 7. Correctly applied pressure to remove parts without damaging work piece/parts. | | |
| 8. Cleaned up work area. | | |
| | | |
| | | |
| | | |

*All items must be rated acceptable

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# Student Competency Sheet

## Unit IV: OPERATING PRESSES

### Module B: Setting Up

### Task 2: SET UP PRESS AND ASSEMBLE PARTS WITH PRESSES

---

## Performance Checklist

1. Place and clamp stationary part to table.
2. Align moveable part in accordance to stationary part.
3. Lubricate both parts.
4. Turn on power to press.
5. Lower ram to moveable part.
6. If gages are available, check hydraulic pressure of operation.
7. Press and assemble to tolerance on blueprint, following proper sequence as outlined.

## Test

Items Needed:
1. Press
2. Blueprint
3. Parts to be assembled
4. Lubricant
5. Clamps
6. Precision measurement instruments

Task:
1. Set up press.
2. Assemble the parts to blueprint specifications.

Standard:
1. All activities on the Instructor Check Sheet must be followed. Activities must be rated acceptable by your instructor.
2. Assembly must be to the tolerance on the blueprint.

---

## Learning Activities

1. Observe demonstration by instructor:
    - a. Press set-up
    - b. Aligning work
    - c. Pressing to assemble parts

2. In Safety Notebook, write:
    a. Three (3) personal safety practices
    b. Three (3) general safety practices

3. Write a list of ten (10) items that require press for assembly. Discuss procedures with class and instructor.

4. Practice assembling parts with press, according to blueprint specifications. Discuss problems with class and instructor.

5. Obtain work order from instructor:
    a. Select safety equipment.
    b. Set up equipment and work piece.
    c. Assemble parts.
    d. Clean up work area.
    e. Have instructor evaluate your work, using the Instructor Check Sheet.

## INSTRUCTOR CHECK SHEET - PRESS SET UP AND PARTS ASSEMBLY

| ACTIVITIES | RATING* | |
|---|---|---|
| | ACCEPTABLE | NOT ACCEPTABLE |
| 1. Utilized safety equipment. | | |
| 2. Cleaned and lubricated press. | | |
| 3. Secured receiving work piece to table. | | |
| 4. Aligned work piece to be pressed to receiving unit. | | |
| 5. Lubricated parts to specifications. | | |
| 6. Aligned work piece with ram. | | |
| 7. Used jigs and attachments correctly. | | |
| 8. Correctly applied pressure to assemble parts without damaging work pieces. | | |
| 9. Cleaned up work area. | | |
| | | |

*All items must be rated acceptable.

## Student Competency Sheet

Unit IV: OPERATING PRESSES

Module B: Setting Up

Task 3: SET UP, REMOVE AND REPLACE PARTS WITH PRESSES

---

**Performance Checklist**

1. Perform set up:
   a. Take and record measurement of position of part to be removed.
   b. Place and clamp stationary part to table.
   c. Align moveable part in accordance to ram.
2. Remove part:
   a. Lubricate both part(s).
   b. Turn on power.
   c. Check disassembly procedures.
   d. Apply pressure to remove part (if gages are available, check pressure of operation).
   e. Remove part(s).
3. Replace part(s):
   a. Lubricate both parts.
   b. Turn on power.
   c. Check disassembly procedures.
   d. Align keyways.
   e. Apply lubricants to all parts.
   f. Insert key and press parts together.
   g. Check tolerance as measured in Step 1: Perform set up.

**Test**

Items Needed:
1. Press
2. Blueprint
3. Gears
4. Pulley or wheel
5. Shaft cut with keyway
6. Key
7. Lubricant
8. Clamps
9. Measuring instrument

Task:
1. Set up press.
2. Remove parts according to blueprint specifications.
3. Reassemble part to a tolerance of ± 1/64".

Standard:
1. All activities on the Instructor Check Sheet must be followed. Activities must be rated acceptable by your instructor.
2. Reassembled part must be to the tolerance of ± 1/64".

---

## Learning Activities

1. Observe demonstrations by instructor:
   a. Setting up arbor and hydraulic presses.
   b. Removing and replacing parts with a press:
      1) Pressing cutters on mandrels
      2) Pressing bearings
      3) Pressing units with key way and splines
2. In Safety Notebook write:
   a. Five (5) personal safety practices
   b. Five (5) general shop safety practices
3. Practice setting up and pressing parts.
4. Discuss different uses of different presses for different jobs. What kinds of jobs are performed in your locale? What kinds of presses are most often used by local industry?
5. Practice applying pressure with press(es) to gage readings assigned by your instructor.
6. Discuss the importance of maintaining tolerance:
   a. What are the tolerances that are most often specified?
   b. What tolerances are usually given for ten commonly pressed parts? (i.e., common to industries in your locale)
   c. What are the consequences if the specified tolerance is not met?
   d. How can an error in tolerance be corrected?
7. Practice using presses: set up presses and remove and replace parts according to blueprints supplied by your instructor.
8. Obtain job work order from instructor:
   a. Select safety equipment
   b. Obtain work pieces
   c. Record position of parts
   d. Set up press
   e. Perform pressing operation
   f. Clean up work area

INSTRUCTOR CHECK SHEET - SET UP, REMOVE AND REPLACE PARTS WITH PRESSES

| | RATING * | |
|---|---|---|
| ACTIVITIES | ACCEPTABLE | NOT ACCEPTABLE |
| 1. Utilized safety equipment. | | |
| 2. Recorded original position of parts. | | |
| 3. Cleaned and lubricated press. | | |
| 4. Secured work piece. | | |
| 5. Aligned work piece to ram. | | |
| 6. Lubricated parts. | | |
| 7. Pressed a part. | | |
| 8. Secured stationary or receiving part. | | |
| 9. Aligned work piece to be pressed into or on receiving part to each other and to ram. | | |
| 10. Lubricated parts. | | |

INSTRUCTOR CHECK SHEET - SET UP, REMOVE AND REPLACE PARTS WITH PRESSES

| | RATING * | |
|---|---|---|
| ACTIVITIES (Continued) | ACCEPTABLE | NOT ACCEPTABLE |
| 11. Pressed parts together. | | |
| 12. Pressed parts to specifications. | | |
| 13. Cleaned work area. | | |
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*All items must be rated acceptable.

## Student Competency Sheet

Unit IV: OPERATING PRESSES

Module B: Setting Up

Task 4: STRAIGHTEN MISCELLANEOUS PARTS WITH PRESSES

---

### Performance Checklist

1. Place bent part between spacers.
2. Use appropriate jig, if necessary.
3. Press part to straighten to a parallel tolerance of ± 1/64".

### Test

Items Needed:
1. Press
2. Bent shaft, bar flat or reel
3. Appropriate jigs
4. Appropriate spacers
5. Straight edge
6. Rule
7. Feeler gauge

Task:
1. Set up press.
2. Straighten the bent part parallel to press bed to an accuracy of ± 1/64".

Standard: The part must be straightened parallel to the press bed to a tolerance of ± 1/64".

---

### Learning Activities

1. Observe demonstration by instructor:
    - a. Straighten bent shafts with press
    - b. Metal elasticity limits
    - c. Safety practices
    - d. Checking shaft alignment with feeler gauge.
2. In Safety Notebook, write:
    - a. Five (5) personal safety practices
    - b. Five (5) general shop safety practices
3. Practice straightening bent shafts on press.

4. Obtain job work order from instructor:
    a. Obtain work piece.
    b. Select safety equipment.
    c. Determine amount out of alignment.
    d. Set up work piece in press.
    e. Apply pressure.
    f. Check alignment and repeat step "e" as necessary.
    g. Clean up work area.
    h. Submit work piece to instructor for evaluation.

## Student Competency Sheet

Unit IV: OPERATING PRESSES

Module B: Setting Up

Task 5: SET UP AND PUNCH MATERIALS WITH PRESS

---

Performance Checklist

1. Secure jig to press table.
2. Secure punch to ram.
3. Hand align jig for table and part clearance.
4. Visually inspect jig mount and punch clearance for safety.
5. Put material in jig.
6. Turn on power to press.
7. Punch part.
8. Inspect and measure part for accuracy according to blueprint.
9. Readjust jig, if necessary.
10. Produce desired number of parts---spot check during operation for possible refinements of adjustments.

Test

Items Needed:
1. Press
2. Blueprint
3. Jig and punch
4. Work piece material
5. Scale (rule) or tape

Task: Punch parts to the tolerance designated on the blueprint.

Standard: Parts must be punched to blueprint specifications.

---

Learning Activities

1. Read manufacturer's manual for capacities.

2. Attend lecture demonstration by instructor:

   a. Setting up for punching operation
   b. Safety practices
   c. Designing jigs and fixtures

3. In Safety Notebook, write:

   a. Five (5) personal safety practices.
   b. Five (5) general shop safety practices

4. Discuss punching operations:

    a. In what kinds of local industries are they used? For what products?
    b. How much tolerance is usually allowed?
    c. Can punching errors be corrected? How?
    d. What is the time and material loss (cost) to the employer caused by misreading blueprints or by inaccurate punching?
    e. What are the consequences to the careless press operator?

5. Under the supervision of your instructor, practice setting up press for punching operation to blueprint specifications supplied by your instructor.

6. Under the supervision of your instructor, practice punching various kinds of scrap materials.

7. Under the supervision of your instructor, measure, mark and punch material to blueprint specifications:

    a. Have your instructor check your work.
    b. Punch duplicates, adjusting as necessary to achieve accuracy.

8. Obtain job work order from instructor:

    a. Obtain jig, punch, necessary tools, and safety equipment.
    b. Set up press to perform operation.
    c. Have instructor inspect set up.
    d. Make trial run.
    e. Make fine adjustments as needed.
    f. Produce five (5) work pieces.
    g. Clean up work area.
    h. Submit all work pieces to instructor for evaluation. (Your instructor will rate your work on the Instructor Check Sheet.)

INSTRUCTOR CHECK SHEET - PUNCHING ON PRESS

| ACTIVITIES | RATING* | |
|---|---|---|
| | ACCEPTABLE | NOT ACCEPTABLE |
| 1. Utilized safety equipment. | | |
| 2. Secured jig to press table. | | |
| 3. Punch properly sharpened. | | |
| 4. Secured punch to ram. | | |
| 5. Aligned punch and jig. | | |
| 6. Punched work piece to specifications. | | |
| 7. Punched duplicate work pieces to specifications. | | |
| 8. Cleaned work area. | | |
| | | |
| | | |

*All items must be rated acceptable.

## Student Competency Sheet

Unit IV: OPERATING PRESSES

Module B: Setting Up

Task 6: SET UP AND BROACH MATERIAL WITH PRESS

---

### Performance Checklist

1. Secure work piece to press table.
2. Secure broach to ram.
3. Align broach and work piece.
4. Check for clearance.
5. Broach to specifications.

### Test

Items Needed:
1. Press
2. Broach
3. Work piece
4. Blueprint
5. Measuring instruments

Task: Broach work piece to tolerance designated on blueprint.

Standard: Part must be broached to blueprint specifications.

---

### Learning Activities

1. Read both of the following:
    a. Machining Fundamentals (Walker), pp. 223-227.
    b. Machinists Library; Basic Machine Shop (Black), pp. 327-338.
2. Read Machinery's Handbook (Oberg/Jones/Horton), pp. 1932-1937.
3. Attend lecture-demonstration by instructor:
    a. Broaching
    b. Shapes of broaches
    c. Care of broaching tools
4. In Safety Notebook, write:
    a. Five (5) personal safety practices
    b. Five (5) general safety practices

5. Sketch shapes of broaches available in your shop.
    a. Discuss uses of these shapes.
    b. Which are used in shops in your locale?

6. Under the supervision of your instructor, practice setting up press for broaching.

7. Under the supervision of your instructor, practice broaching:
    a. Several kinds of materials.
    b. To different tolerances, as assigned by your instructor.

8. Obtain job work order from instructor:
    a. Selected specified broach, safety equipment, and needed tools and work piece.
    b. Secure and align work piece and broach.
    c. Clean up work area.
    f. Submit work piece to instructor for evaluation.

# UNIT V

# OPERATING DRILL PRESSES

## Terminal Objectives

Upon completion of the modules in this unit, you will be able to:

- Inspect drill presses for safe operational condition
- Perform preventive maintenance on a drill press
- Consider the material of the work piece to be drilled
- Determine the holding technique to be used
- Mount and secure work in a holding device
- Select the tool or cutter for drill press operation
- Sharpen a drill using a grinding wheel, by the freehand technique, or by using a drill grinding jig
- Secure a tool or cutter in a drill press spindle
- Select a sleeve to suit the drill
- Set a drill press for proper feeds and speeds for a specified operation
- Center punch a hole location
- Drill a hole to a specified size
- Countersink a hole to meet drawing requirements
- Counterbore to a depth specified in a blueprint
- Spot-face a work piece
- Ream a hole to a specified size
- Hand tap a hole to blueprint specifications
- Use a tapping attachment to tap a hole
- Use the automatic feed on a drill press

## Student Competency Sheet

Unit V: OPERATING DRILL PRESSES

Module A: Drill Press Maintenance

Task 1: INSPECT DRILL PRESSES FOR SAFE OPERATIONAL CONDITION

---

### Performance Checklist

1. Inspect belts for wear and tension.
2. Inspect guards for working condition.
3. Inspect spindle condition.
4. Inspect table condition.
5. Inspect work holding devices for working condition.

### Test

Items Needed:
1. Drill press
2. Service manual
3. Safety charts

Task: Inspect drill press for safety and operational condition.

Standard:
1. All parts of drill press will be inspected for safety and operational condition.
2. All violations of safety standards will be noted.
3. Proper corrective measures will be recommended for all safety violations.

---

### Learning Activities

1. Read two of the following:
   a. Drilling Technology (Krar/Oswald), pp. 1-20.
   b. Machining Fundamentals (Walker), pp. 95-120.
   c. Machinists Library; Basic Machine Shop (Black), pp. 89-126.

2. Attend a lecture-demonstration by instructor:

   a. Drill press operation.
   b. Inspecting drill press for safety.

3. In Safety Notebook, write:

   a. Five personal safety practices.
   b. Five general shop safety practices.

4. Read and discuss Information Sheet V-A-1 (Drill Press Safety).

5. Discuss the reasons for:

    a. Wearing eye protection at all times, when in the shop.
    b. Following all machine and general safety rules with 100% accuracy.
    c. Running tools at proper speeds when machining.
    d. Changing speed regulations only when the manufacturer's specs call for a change.

6. Draw a drill press:

    a. Label all parts.
    b. Put a circle around all safety features.
    c. Have your instructor check your drawing.

7. Demonstrate the use of all machine switches and levers.

8. Inspect a drill press:

    a. Write up all violations of safety standards.
    b. Write up suggested corrections for all violations.
    c. Have your instructor evaluate your written report. (The report must (1) note all safety violations and (2) include corrective measure(s) for all violations.)

## Information Sheet V-A-1

## DRILL PRESS SAFETY

** Each new student must be present for the instructors lesson on Drill Press Safety prior to operating any drill press within the shop.

** Each student must follow and demonstrate all safety rules and regulations referring to the Drill Press.

1. Wear approved eye protection at all times.
2. Be thoroughly familiar with all the switches and levers that are used to operate the machine.
3. Tuck in loose clothing so there is no chance of them becoming entangled with the rotating drill.
4. See that all safety guards are in place.
5. Use sharp and properly ground tools or drills at all times.
6. Clamp the work solidly. Do not hold it in your hands. Should the drill break through, a merry-go-round effect may set up, causing serious and painful injuries.
7. Always use a wood block beneath the drill being removed to avoid damaging small drills, or to prevent large drills from dropping through on your foot.
8. Remove chuck key immediately after tightening drill in drill chuck.
9. Permit the drill to stop of its own accord after the power has been turned off. Do not try to stop it with your hand.
10. Do not have rags of any kind near drill press while drilling. Rags may get caught in revolving spindle setting up potential hazards that may cause serious injuries to operator.
11. Place all oily and dirty rags in a closed container when the job is finished.
12. Never use bare hands to remove chips from drill press. Always use a brush.
13. Do not reach around or in back of revolving drill.
14. Change speed regulation only when power is on and machine is running, with the exception of the radial.
15. Have small drills revolve at high speed, large drills at low speeds. Reduce speed about 50 percent when drilling cast iron.
16. Keep your head back and well away from any moving parts.

# Student Competency Sheet

Unit V: OPERATING DRILL PRESSES

Module A: Drill Press Maintenance

Task 2: PERFORM PREVENTIVE MAINTENANCE ON DRILL PRESS

---

## Performance Checklist

1. Inspect for maintenance (need for minor repair).
2. Clean table.
3. Clean column.
4. Clean and adjust spindle sleeve.
5. Determine that depth stop is functional.
6. Inspect belts; replace if necessary.
7. Adjust belt tension.

NOTE: In addition, all items in the specifications in the drill press service manual must be checked.

## Test

Items Needed:
1. Drill press
2. Service manual
3. Cleaner
4. Lubricant
5. Cleaning rags

Task: Perform preventive maintenance on the drill press.

Standard:
1. All items on the Instructor Check Sheet must be rated acceptable.
2. All items (steps) of the procedure listed in the service manual must be rated by your instructor as satisfactorily performed.

---

## Learning Activities

1. Read two of the following:
   a. Machining Fundamentals (Walker), pp. 95-120.
   b. Machinists Library; Basic Machine Shop (Black), pp. 89-100.
   c. Metalworking Technology and Practices (Ludwig and McCarthy), pp. 203-228.

2. Read and discuss the manufacturer's maintenance manual.

3. Observe demonstrations by instructor:

    a. Table adjustment and cleaning.
    b. Spindle cleaning and adjustment.
    c. Belt adjustment.

4. Under the supervision of your instructor, work with a partner and perform maintenance operations on the drill press.

5. Under the supervision of your instructor, inspect, clean, and adjust maintenance items on the drill press. Your instructor will evaluate your work. All items on the Instructor Check Sheet must be rated acceptable, in addition to any other steps listed in the manufacturer's service manual.

INSTRUCTOR CHECK SHEET

| ACTIVITIES | RATING | |
|---|---|---|
| | ACCEPTABLE | NOT ACCEPTABLE |
| 1. Cleaned and lubricated table. | | |
| 2. Determine that table clamping system is functional. | | |
| 3. Cleaned column. | | |
| 4. Cleaned and adjusted spindle sleeve. | | |
| 5. Determine that depth stop is functional. | | |
| 6. Inspected belts. | | |
| 7. Adjusted belts. | | |
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# Student Competency Sheet

## Unit V: OPERATING DRILL PRESSES

### Module B: Setting Up for Drilling

### Task 1: CONSIDER MATERIAL OF WORK PIECE TO BE DRILLED

---

## Performance Checklist

1. Refer to blueprint to identify material to be drilled.
2. Refer to appropriate tables in machinery handbook to determine hardness of material.
3. Use appropriate table specifications to determine characteristics of material.
4. Use appropriate table specifications to determine cutting speed.
5. Determine drill size to be used.
6. Determine drill speed and feed.

## Test

Items Needed:
1. Blueprint which identifies material to be drilled
2. Machinery handbook

Task:
1. Determine, to table specifications:
    a. Material hardness
    b. Condition
    c. Cutting speed
2. Identify:
    a. Drill size
    b. Drill speed and feed

Standard: Your instructor must rate your selection as satisfactory, according to table specifications.

---

## Learning Activities

1. Read two (2) of the following:

    a. Drilling Technology (Krar/Oswald), pp. 1-99.
    b. Machining Fundamentals (Walker), pp. 95-120.
    c. Machinists Library; Basic Machine Shop (Black), pp. 89-126.
    d. Metalwork Technology and Practice (Ludwig/McCarthy), pp. 193-229.

2. Attend lecture-demonstrations by instructor:
   - a. Reading blueprints
   - b. Drill press set up and operation
   - c. Selecting speeds, feeds and drills

3. In Safety Notebook, write:
   - a. Five (5) personal safety practices
   - b. Five (5) general shop safety practices

4. Write a procedure for drilling a 1/2 inch hole, 1/2" deep into:
   - a. Aluminum
   - b. Steel (low carbon)
   - c. Mild steel
   - d. Stainless steel
   - e. Tool steel

5. Obtain a blueprint from your instructor:
   - a. Use the Performance Checklist and Machinery Notebook to determine drill press set up.
   - b. Write your findings.
   - c. Have your instructor check your work.

6. Practice setting up drill press to blueprint specifications.

7. Obtain job work order from instructor:
   - a. Select material specified, safety equipment, and necessary tools.
   - b. Set up drill press:
     - (1) Secure work piece.
     - (2) Set speed.
     - (3) Select drill or drills to be used.
   - c. Have instructor evaluate set up. All items on the Instructor Check Sheet must be rated acceptable.

INSTRUCTOR CHECK SHEET - DRILL PRESS CHECKLIST

| ACTIVITIES | RATING | |
|---|---|---|
| | ACCEPTABLE | NOT ACCEPTABLE |
| 1. Identified material correctly. | | |
| 2. Mounted work piece correctly. | | |
| 3. Mounted drill. | | |
| 4. Selected correct drill(s) to meet specifications. | | |
| 5. Set speed correctly to meet specifications. | | |
| 6. Set feed correctly. | | |
| | | |
| | | |
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## Student Competency Sheet

Unit V: OPERATING DRILL PRESSES

Module B: Setting Up for Drilling

Task 2: DETERMINE HOLDING TECHNIQUE

---

### Performance Checklist

1. Identify material.
2. Identify operation to be performed.
3. Determine best holding technique.

### Test

Items Needed:
1. Job specifications indicating circular, flat, holed or other material
2. Assortment of holding devices, including:
    a. Vise with parallel bars and accessories
    b. Hold down accessories (for table)
    c. V-block with yoke and clamps
    d. Clamps, straps, bolts
    e. Jigs, fixtures

Task: Determine the proper holding technique to meet job specifications.

Standard: All of your choices must be:
1. Indicated (yes or no) on the attached Check Sheet
2. Approved by your instructor.

---

### Learning Activities

1. Read two of the following:

    a. Drilling Technology (Krar/Oswald), pp. 20-31.
    b. Machining Fundamentals (Walker), pp. 101-105.
    c. Machinist Library: Basic Machine Shop (Black), pp. 116-125.
    d. Metalwork Technology and Practice (Ludwig/McCarthy), pp. 208-212.

2. Attend lecture-demonstration by instructor:

    a. Use of work-holding devices for drill press.
    b. Mounting work pieces for drill press operation.

3. Write a list of work holding devices:
    a. Indicate their uses.
    b. Have your instructor check your list.
4. Obtain three (3) job work orders from instructor. For each:
    a. Obtain material specified.
    b. Determine best method of securing.
    c. Have instructor evaluate set-up, using Instructor Check Sheet.

## INSTRUCTOR CHECK SHEET - DETERMINE HOLDING TECHNIQUE

MATERIAL________________________ (circular, flat, holed, other)

INSPECTED________________________ (approved/not approved by:)

| HOLDING TECHNIQUE SELECTED* | | | | PROPER CHOICE (COMMENTS) | |
|---|---|---|---|---|---|
| | | YES | NO | YES | NO |
| VICE | Parallel Bars | | | | |
| | Accessories | | | | |
| MATERIAL TO TABLE | Hold Down Accessories | | | | |
| V-BLOCK | Yoke | | | | |
| | Clamps | | | | |
| CLAMPS, STRAPS, BOLTS | | | | | |
| JIGS, FIXTURES | | | | | |
| OTHER (SPECIFY) | | | | | |

*For safe operation and accuracy of drilling, the proper holding technique must be selected.

## Student Competency Sheet

Unit V: OPERATING DRILL PRESSES

Module B: Setting up for Drilling

Task 3: MOUNT AND SECURE WORK IN HOLDING DEVICE

---

### Performance Checklist

1. Select and mount proper work-holding device.
2. Select appropriate clamps.
3. Secure work in work holding-device.
4. Tap material to insure seating.
5. Tighten both table and table brackets.

### Test

Items Needed:
1. Job specifications
2. Assortment of work holding-devices
3. Work piece
4. Mallet
5. Drill press

Task: Using the drill press, mount and secure work in holding device to perform the job specification.

Standard:
1. Work will be mounted and secured in holding device by the correct method to perform the job specifications.
2. Your performance must be rated satisfactory by your instructor.

---

### Learning Activities

1. Read two (2) of the following:
   a. Drilling Technology (Krar/Oswald), pp. 20-31.
   b. Machining Fundamentals (Walker), pp. 101-105.
   c. Machinists Library; Basic Machine Shop (Black), pp. 116-125.
   d. Metalwork Technology and Practice (Ludwig/McCarthy), pp. 208-212.
2. Attend lecture-demonstrations by instructor:
   a. Work-holding techniques for drill press
   b. Mounting

3. In Safety Notebook, write:

    a. Five (5) personal safety practices.
    b. Five (5) general shop safety practices.

4. Practice mounting assorted work pieces.

5. Obtain job work order from instructor:

    a. Select material, safety equipment, and necessary tools to perform operation.
    b. Secure work piece.
    c. Have instructor evaluate set-up.
    d. Clean up work area.

## Student Competency Sheet

Unit V: OPERATING DRILL PRESSES

Module B: Setting Up for Drilling

Task 4: SELECT TOOL OR CUTTER FOR DRILL PRESS OPERATION

---

### Performance Checklist

1. Identify operation to be performed.
2. Identify material specified.
3. Select tool or tools to perform operation to specifications.

### Test

Items Needed:
1. Blueprint for a drill press job
2. Assortment of straight shank and taper shank tools or cutters, such as:
   a. Counterbore
   b. Countersink
   c. Drill
   d. Reamer
   e. Spot facing tool

Task: Select the appropriate tool or cutter for the drill press job specified on the blueprint.

Standard: Your instructor must approve the tool or cutter you select.

---

### Learning Activities

1. Read two of the following:

   a. Drilling Technology (Krar/Oswald), pp. 32-40 and 108-144.
   b. Machining Fundamentals (Walker), pp. 95-101 and 109-116.
   c. Machinists Library; Basic Machine Shop (Black), pp. 101-114.

2. Attend lecture-demonstrations by instructor:

   a. Selecting cutters for drill press.
   b. Sharpening cutters.
   c. Using cutters.

3. In Safety Notebook, write:

   a. Five personal safety practices.
   b. Three general shop safety practices.

4. Obtain job work order from instructor:
    a. Determine operation and cutter required.
    b. Have instructor evaluate selection.

## Student Competency Sheet

Unit V: OPERATING DRILL PRESSES

Module B: Setting Up for Drilling

Task 5: SHARPEN DRILL USING GRINDING WHEEL, FREEHAND TECHNIQUE AND USING DRILL GRINDING JIG

---

### Performance Checklist

1. Follow manufacturer's manual to operate drill grinding fixture.
2. Dress and true grinding wheel.
3. Grind lip clearance, length, and angle to specifications.
4. Check for sharpness.

### Test

Items Needed:

1. Grinder
2. Wheel dresser
3. Drill grinding fixture
4. Drills
5. Drill reference
6. Drill point gage
7. Manufacturer's manual

Task:

1. Use the drill grinding fixture to sharpen the drill.
2. Check for sharpness.

Standard:

1. Drill must be sharpened according to the manufacturer's specifications.
2. Your instructor must rate all activities on the Performance Checklist as being satisfactorily performed.

---

### Learning Activities

1. Read two of the following:
    a. Drilling Technology (Krar/Oswald), pp. 51-58.
    b. Machining Fundamentals (Walker), pp. 107-109.
    c. Machinists Library; Basic Machine Shop (Black), pp. 225-246.
2. Read manufacturer's manual for drill grinding fixture.

3. Attend lecture-demonstrations by instructor.

    a. Cutter angles
    b. Testing for sharpness
    c. Sharpening cutters
    d. Grinder safety
    e. Using grinding jigs

4. In Safety Notebook, write:

    a. Three (3) personal safety practices.
    b. Three (3) general shop safety practices.

5. Sketch drill bits and label parts.

6. Practice sharpening drill bits:

    a. Sharpen free hand.
    b. Sharpen with grinding jig.

7. From your instructor, obtain selection of drill bits to be sharpened free hand:

    a. True grinding wheel.
    b. Determine correct lip clearance for bits.
    c. Grind bits and check with gauge.
    d. Have instructor evaluate work.
    e. Clean up work area.

8. From your instructor obtain selection of drill bits to be sharpened using grinding fixture:

    a. Determine clearance angle.
    b. Set up jig.
    c. Sharpen bits to specifications.
    d. Have instructor evaluate set-up and sharpness of bits.
    e. Clean up work area.

## Student Competency Sheet

Unit V: OPERATING DRILL PRESSES

Module B: Setting Up for Drilling

Task 6: SECURE TOOL OR CUTTER IN DRILL PRESS SPINDLE

---

### Performance Checklist

#### Straight Shank Holders

1. Clean shank of chuck.
2. Align tang of chuck into drill press spindle.
3. Secure chuck into drill press spindle.
4. Secure tool/cutter into chuck.
5. Have work inspected and approved.
6. Insert drift and remove chuck.

#### Taper Shank Holders

1. Clean shank of tool/cutter.
2. Secure tool/cutter into drill press spindle:
   a. Align tang.
   b. Select appropriate sleeve.
   c. Snug tool/cutter.
3. Have work inspected and approved.
4. Insert drift and remove tool/cutter.

### Test

Items Needed:

1. Assortment of straight shank and taper shank tools or cutters, such as:
   a. Counterbore
   b. Countersink
   c. Drill
   d. Reamer
   e. Spot-facing tool
2. Chuck and key
3. Mallet
4. Drift
5. Tapered sleeve
6. Drill press

Task:

1. Secure one (1) straight shank in the drill press spindle.
2. Secure one (1) taper shank tool or cutter in the drill press spindle.

Standard:

1. The straight shank must be mounted by using the steps in the Performance Checklist.
2. The taper shank tools or cutter must be mounted by using the steps in the Performance Checklist.
3. All activities must be rated satisfactory by your instructor.

Learning Activities

1. Read two (2) of the following:
    a. Drilling Technology (Krar/Oswald), pp. 1-14.
    b. Machining Fundamentals (Walker), pp. 95-101.
    c. Machinists Library; Basic Machine Shop (Black), pp. 89-100.

2. Attend lecture-demonstration by instructor:
    a. Straight shank holders.
    b. Taper shank holders.
    c. Morse taper.
    d. Securing tool in spindle.

3. In Safety Notebook, write:
    a. Three (3) personal safety practices.
    b. Three (3) general shop safety practices.

4. Sketch straight shank holder and taper shank holder; label parts.

5. Practice mounting straight shank and taper shank holder in spindle of drill press.

6. Obtain straight shank holder and taper shank holder and mount in spindle. Have instructor evaluate technique.

# Student Competency Sheet

Unit V: OPERATING DRILL PRESSES

Module B: Setting Up for Drilling

Task 7: SELECT SLEEVE TO SUIT DRILL

---

## Performance Checklist

1. Determine drill press spindle hole diameter.
2. Measure large diameter of drill.
3. Select proper sleeve from table.
4. Have selection approved.

## Test

Items Needed:
1. Machinist's handbook
2. Drill
3. Assortment of sleeves or shell sockets
4. Precision measurement instruments
5. Machinist's rule

Task: Select the proper sleeve to be used with the drill, according to table specifications.

Standard: The selection must be approved by your instructor as being the correct selection, according to table specifications in the machinist's handbook.

---

## Learning Activities

1. Read two (2) of the following:
   a. Drilling Technology (Krar/Oswald), pp. 10-11.
   b. Machining Fundamentals (Walker), pp. 98-101.
   c. Machinists Library; Basic Machine Shop (Black), pp. 115-116.
2. Attend lecture-demonstrations by instructor on selecting sleeves and sockets.
3. In Safety Notebook, write:
   a. Three (3) personal safety practices
   b. Three (3) general shop safety practices

4. Obtain drill to be mounted in drill press:

    a. Determine spindle size and taper.
    b. Determine drill shank taper.
    c. Select sleeve or socket to match drill shank and drill spindle.
    d. Have your instructor evaluate your selection.

## Student Competency Sheet

Unit V: OPERATING DRILL PRESSES

Module B: Setting Up for Drilling

Task 8: SET DRILL PRESS FOR PROPER FEEDS AND SPEEDS FOR OPERATION PERFORMED

---

### Performance Checklist

1. Determine speed and feed.
2. Adjust spindle speed.
3. Set drill press for proper feed.

### Test

Items Needed:
1. Blueprint
2. Manufacturer's operation manual
3. Drill press

Task:
1. Use the blueprint and manufacturer's manual to select drill press speed and feed.
2. Set the drill press for speed and feed.

Standard:
1. Your instructor must approve your selection of speed and feed.
2. The drill press speed and feed must be set with 100% accuracy.

---

### Learning Activities

1. Read two (2) of the following:
   a. Drilling Technology (Krar/Oswald), pp. 59-71.
   b. Machining Fundamentals (Walker), pp. 106-107.
   c. Machinists Library; Basic Machine Shop (Black), pp. 101-103.
2. Read drill press manufacturer's operation manual for setting spindle speeds and feeds. Discuss with instructor and class.
3. Attend lecture-demonstrations by instructor:
   a. Selecting speeds and feeds.
   b. Drill press speed adjustments.
   c. Feed adjustments.

4. In Safety Notebook, write:

    a. Five (5) personal safety practices.
    b. Five (5) general shop safety practices.

5. Discuss why speed regulator should be changed only when manufacturer's specifications call for change.

6. Demonstrate to partner, instructor, or class:

    a. Adjusting speed to specifications.
    b. Adjusting feed.

7. Review items on the Instructor Check Sheet that is included in this task packet:

    a. Discuss why these items are important.
    b. Demonstrate acceptable performance of these items.

8. Obtain job work order from instructor:

    a. Determine material and operation to be performed.
    b. Calculate spindle speed.
    c. Set spindle speed.
    d. Set feed.
    e. Have your instructor evaluate your work.

9. Set up for drilling operation, following blueprint specs. Have your instructor rate your performance on the Instructor Check Sheet included in this task packet.

INSTRUCTOR CHECK SHEET - SETTING UP FOR DRILLING OPERATION

| ACTIVITIES | RATING |  |
|---|---|---|
|  | ACCEPTABLE | NOT ACCEPTABLE |
| 1. Selected proper work-holding devices. |  |  |
| 2. Used proper operator stance at the machine. |  |  |
| 3. Selected and used correct equipment for various operations. |  |  |
| 4. Selected proper RPM for the operation being done. |  |  |
| 5. Dressed properly for shop work. |  |  |
| 6. Used safety guards. |  |  |
| 7. Placement of tools and lubricant at the drill press was correct and appropriate. |  |  |
| 8. Assured cleanliness of machine, tools, and machine area surrounding the operator's drill press. |  |  |
|  |  |  |
|  |  |  |

## Student Competency Sheet

### Unit V: OPERATING DRILL PRESSES

### Module B: Setting Up for Drilling

### Task 9: CENTER PUNCH HOLE LOCATION

---

## Performance Checklist

1. Locate center of hole.
2. Put small punch mark at center point.
3. Center punch center point.

## Test

Items Needed:
1. Blueprint
2. Work piece
3. Dividers
4. Hermaphrodite caliper
5. Center square
6. Surface gauge
7. Surface plate
8. V-block
9. Center punch
10. Prick punch
11. Ball peen hammer

Task: Center punch the hole location.

Standard: Center punch hole location must be accurate to within 0.010" to 0.001".

---

## Learning Activities

1. Read one (1) of the following:
    a. Drilling Technology (Krar/Oswald), pp. 80-100.
    b. Machining Fundamentals (Walker), pp. 109-112.
2. Attend lecture-demonstrations by instructor:
    a. Layout and blueprint reading for punch location.
    b. Using center punch.

3. In Safety Notebook, write:
   a. Two (2) personal safety practices.
   b. Two (2) general shop safety practices.

4. Practice using tools to center punch.

5. Work from a blueprint provided by your instructor:
   a. Obtain work piece(s) and tools.
   b. Measure/mark work piece(s) as specified.
   c. Center punch as indicated.
   d. Have your instructor check your work.

6. After completing SCS V-C-1, (Center Punch Hole Location), practice drilling (1) without using center punch and (2) using center punch technique:
   a. Write a report comparing both techniques.
   b. Discuss your report with your instructor and/or class.

## Student Competency Sheet

Unit V: OPERATING DRILL PRESSES

Module C: Drilling

Task 1: DRILL HOLE TO SIZE

---

### Performance Checklist

1. Identify work piece material.
2. Select holding device and accessories.
3. Secure work in holding device and check setup for rigidity.
4. Determine hole size.
5. Align work piece and center drill.
6. Select and mount drill.
7. Drill to dimensions (lubricate, if applicable).
8. Deburr hole.

### Test

Items Needed:
1. Blueprint
2. Work piece
3. Drill press and equipment
4. Lubricants
5. Work-holding devices
6. Drills
7. Tables of drills
8. Combination drill and countersink
9. Deburring tool

Task: Drill a hole in the work piece to the size specified in the blueprint.

Standard: The hole must be drilled to an accuracy of within:
+0.005" + 0.005 (nominal drill diameter in inches).
+0.001" + 0.003 (nominal drill diameter in inches).

---

### Learning Activities

1. Read one (1) of the following:
   a. *Drilling Technology* (Krar/Oswald), pp. 75-99.
   b. *Machining Fundamentals* (Walker), pp. 109-113.

2. Attend lecture-demonstrations by instructor:
   a. Mounting drill bits
   b. Layout and center punch
   c. Mounting and securing work piece
   d. Drilling
   e. Step drilling

3. In Safety Notebook, write:
    a. Three (3) personal safety practices.
    b. Three (3) general shop safety practices.

4. Write a procedure for drilling a 1/2" diameter hole in:
    a. 1/4 inch - thick aluminum
    b. 1 inch - thick aluminum
    c. 1 inch - thick mild steel

5. Under the supervision of your instructor, practice drilling on drill press.

6. Obtain job work-order from instructor:
    a. Select material, bits, and safety equipment.
    b. Layout work piece to specifications.
    c. Mount work piece.
    d. Mount drill.
    e. Drill to specification.
    f. Clean up work area.
    g. Have instructor evaluate work for accuracy.

INSTRUCTOR CHECK SHEET - DRILLING HOLE

| ACTIVITIES | RATING | |
|---|---|---|
| | ACCEPTABLE | NOT ACCEPTABLE |
| 1. Identified material correctly. | | |
| 2. Drill selection was correct. | | |
| 3. Mounted work securely. | | |
| 4. Mounted bit correctly. | | |
| 5. Set speed and feed to specifications. | | |
| 6. Drilled work to specifications. | | |
| 7. Cleaned work area. | | |
| | | |
| | | |
| | | |

## Student Competency Sheet

Unit V: OPERATING DRILL PRESSES

Module C: Drilling

Task 2: COUNTERSINK HOLE TO DRAWING REQUIREMENTS

---

### Performance Checklist

1. Center punch hole location.
2. Secure work piece in work-holding device.
3. Select drill and drill hole to be countersunk.
4. Select countersink and secure in drill press.
5. Set countersink central with hole (if applicable), or align countersink to hole.
6. Set drill press stops, speed.
7. Apply cutting oil (if applicable) and countersink to specifications.
8. Check accuracy of countersink.

### Test

Items Needed:
1. Blueprint
2. Work piece
3. Work-holding device
4. Drill press and accessories
5. Center punch
6. Drills
7. Countersinks
8. Cutting oil
9. Flathead screw or plug gage
10. Precision measurement instruments

Task: Working at the drill press, drill then countersink the hole to blueprint specifications.

Standard: The hole must be drilled and countersunk according to blueprint specifications.

---

### Learning Activities

1. Read one (1) of the following:
   a. Drilling Technology (Krar/Oswald), pp. 111-115.
   b. Machining Fundamentals (Walker), pp. 114-115.
   c. Machinists Library; Basic Machine Shop (Black), pp. 110-111.

2. Attend demonstration by instructor on countersinking.

3. In Safety Notebook, write:
    a. Three (3) personal safety practices
    b. Three (3) general shop safety practices

4. Sketch countersink tool; label parts.

5. Under the supervision of your instructor, practice the countersinking procedure.

6. Obtain job work order from instructor:
    a. Select material and lay out to specifications.
    b. Drill to specifications.
    c. Countersink to specifications.
    d. Clean up work area.
    e. Submit work piece to instructor for evaluation.

## Student Competency Sheet

Unit V: OPERATING DRILL PRESSES

Module C: Drilling

Task 3: COUNTERBORE TO DEPTH SPECIFIED IN BLUEPRINT

---

### Performance Checklist

1. Center punch hole location.
2. Secure work piece in work-holding device.
3. Select drill and drill hole to be counterbored.
4. Select counterbore and secure in drill press.
5. Set drill press stops, speed.
6. Apply cutting oil (if applicable) and counterbore to specifications.
7. Check accuracy of counterbore.

### Test

Items Needed:

1. Blueprint
2. Work piece
3. Work-holding device
4. Drill press and accessories
5. Center punch
6. Drills
7. Table for counterbore sizes
8. Counterbores
9. Cutting oil
10. Cap screws
11. Machine screws
12. Precision measurement instruments

Task: Drill and then counterbore a hole to blueprint and table specifications.

Standard: The counterbore must be accurate according to specifications of the blueprint and the table for counterbore sizes.

---

### Learning Activities

1. Read:

   a. Drilling Technology (Krar/Oswald), pp. 111-115.
   b. Machining Fundamentals (Walker), p. 115.
   c. Machinists Library; Basic Machine Shop (Black), p. 111-113.

2. Attend lecture-demonstration by instructor on counterboring.

3. In Safety Notebook, write:

   a. Three (3) personal safety practices.
   b. Three (3) general shop safety practices.

4. Under the supervision of your instructor, practice countersinking.

5. Sketch a counterboring tool and label parts.

6. Obtain job work order from instructor:

   a. Select safety equipment and material.
   b. Lay out work piece to specifications.
   c. Drill to specifications.
   d. Counterbore to specifications.
   e. Clean up work area.
   f. Submit work piece to instructor for evaluation.

## Student Competency Sheet

Unit V: OPERATING DRILL PRESSES

Module C: Drilling

Task 4: SPOT-FACE WORK PIECE

---

### Performance Checklist

Spot-Face Flat Surface

1. Identify work piece material.
2. Select holding device and accessories.
3. Secure work in holding device and check setup for rigidity.
4. Align work piece.
5. Spot-face work piece.
   a. Lubricate
   b. Face to dimensions

Spot-Face Hole

1. Use steps 1-4 under Spot-Face Flat Surface.
2. Align pilot with hole.
3. Spot-face work piece.
   a. Lubricate
   b. Face to dimensions

### Test

Items Needed:
1. Blueprint
2. Spot-facing tools
3. Lubricant
4. Work piece

Task: Spot-face the work piece according to blueprint specifications.

Standard: The work piece must be spot-faced to blueprint specifications.

---

### Learning Activities

1. Read:

   a. Drilling Technology (Krar/Oswald), pp. 38 and 113.
   b. Machining Fundamentals (Walker), p. 115.
   c. Machinists Library; Basic Machine Shop (Black), p. 113.

2. Attend demonstration by instructor on spot facing.

3. In Safety Notebook, write:

   a. Three (3) personal safety practices
   b. Three (3) general shop safety practices

4. Write an explanation of why spot facing is used.

5. Distinguish between counterboring and spot facing.

6. Practice spot facing flat surfaces and holes, as assigned by your instructor.

7. Obtain job work orders from instructor:

   a. Select material, tools, and safety equipment.
   b. Drill or bore to specifications.
   c. Spot face to specifications.
   d. Clean up.
   e. Have instructor evaluate work piece.

## Student Competency Sheet

Unit V: OPERATING DRILL PRESSES

Module C: Drilling

Task 5: REAM HOLE TO SIZE

---

### Performance Checklist

1. Identify work piece material,
2. Select holding device and accessories.
3. Secure work in holding device and check setup for rigidity.
4. Align work piece and center drill.
5. Select drill and drill work piece to dimensions (lubricate, if necessary).
6. Select reamer and ream to specifications.

### Test

Items Needed:
1. Work piece
2. Blueprint
3. Holding devices
4. Lubricant
5. Drills
6. Combination drill and countersink
7. Reamers

Task: Ream the hole according to blueprint specifications.

Standard: The hole must be reamed to an accuracy of +0.0001" minimum to +0.0005" maximum, according to the blueprint specifications.

---

### Learning Activities

1. Read two (2) of the following:
   a. Drilling Technology (Krar/Oswald), pp. 116-126.
   b. Machining Fundamentals (Walker), pp. 113-114.
   c. Machinists Library; Basic Machine Shop (Black), p. 114.

2. Attend lecture-demonstration by instructor:
   a. Care and handling of reamers.
   b. Hand reaming.
   c. Reaming on drill press.

3. In Safety Notebook, write:
   a. Three (3) personal safety practices.
   b. Three (3) general shop safety practices.

4. Write a list of different types of reamers in your shop.

5. Identify and explain the use of all the reamers you listed in Learning Activity #4.

6. Practice reaming on drill press.

7. Obtain job work order from instructor:
   a. Select materials, tools, and safety equipment.
   b. Lay out work and drill to specifications.
   c. Ream to specifications.
   d. Clean up work area.
   e. Have instructor evaluate work piece.

## Student Competency Sheet

Unit V: OPERATING DRILL PRESSES

Module C: Drilling

Task 6: HAND TAP HOLE TO BLUEPRINT SPECIFICATIONS

---

### Performance Checklist

1. Select tap drill and tap as specified on blueprint.
2. Mount and secure work piece to drill table vise.
3. Mount, secure, and align combination drill and countersink to work piece.
4. Select and set drill press speed.
5. Drill and countersink work piece.
6. Mount tap in tap wrench and align to drilled hole.
7. Mount dead center in drill chuck and align to tap wrench center.
8. Hand tap hole to specifications using lubricant.

### Test

Items Needed:

1. Blueprint
2. Work piece
3. Machinist's handbook
4. Drill press
5. Tap drills
6. Tap wrench
7. Taps
8. Drill chuck and key
9. Drill press vise
10. Straps and bolts
11. Combination drill and countersink
12. Dead center
13. Lubricant
14. Appropriate measurement instruments

Task: Work at the drill press, and hand tap the hole to blueprint specifications.

Standard: The hand-tapped hole must meet blueprint specifications.

---

### Learning Activities

1. Read two (2) of the following:

    a. Drilling Technology (Krar/Oswald), pp. 127-135.

   b. Machining Fundamentals (Walker), pp. 116.
   c. Machinists Library; Basic Machine Shop (Black), pp. 107-110.

2. Attend lecture-demonstration by instructor on hand tapping holes on drill press.

3. In Safety Notebook, write:

   a. Five (5) personal safety practices.
   b. Three (3) general shop safety practices.

4. Identify and write a list of types of taps available for use on drill press.

5. Explain the use of the taps used in your shop.

6. Practice using drill press for hand tapping technique.

7. Obtain job work order from instructor:

   a. Select material, tools, and safety equipment.
   b. Lay out and drill to specifications.
   c. Tap hole using hand technique.
   d. Have instructor evaluate set-up and finished work piece.
   e. Clean up work area.

## Student Competency Sheet

Unit V: OPERATING DRILL PRESSES

Module C: Drilling

Task 7: USE TAPPING ATTACHMENT TO TAP HOLE

---

### Performance Checklist

1. Select tap drill and tap.
2. Secure work piece to drill press table.
3. Set speed and feed.
4. Center drill, then drill hole.
5. Mount and secure tapping attachment and tap.
6. Lubricate and tap hole to specifications.

### Test

Items Needed:

1. Blueprint
2. Machinery handbook
3. Work piece
4. Work-holding device
5. "Go and no-go" gauges
6. Cutting oil
7. Drill press
8. Combination drill and countersink
9. Tap drill
10. Tap
11. Tapping attachment
12. Drill chuck and key

Task: Use tapping attachment and the equipment supplied to drill and then tap a hole to blueprint specifications.

Standard: The hole must be drilled and tapped to meet blueprint specifications.

---

### Learning Activities

1. Read two (2) of the following:

   a. Drilling Technology (Krar/Oswald), pp. 133-134.
   b. Machining Fundamentals (Walker), pp. 116-117.
   c. Machinists Library; Basic Machine Shop (Black), pp. 107-110.

2. Read the manufacturer's instructions for tapping attachment.

3. Attend demonstration by instructor on using tapping attachment.

4. Practice using tapping attachment.

5. Obtain job work order from instructor:

    a. Obtain material, tools, and safety equipment.
    b. Lay out and drill to specifications.
    c. Tap holes using tapping attachment.
    d. Have instructor evaluate set-up and finished work piece.
    e. Clean up work area.

## Student Competency Sheet

Unit V : OPERATING DRILL PRESSES

Module C: Drilling

Task 8: USE AUTOMATIC FEED ON DRILL PRESS

---

### Performance Checklist

1. Determine drill press operation.
2. Secure work piece in work-holding device.
3. Secure tools and attachments.
4. Align tool to work piece.
5. Determine and set feed.
6. Have setup checked and approved.
7. Engage power feed and perform drill press operation.

### Test

Items Needed:
1. Blueprint
2. Machinist's handbook
3. Work piece
4. Drill press
5. Drill press accessories

Task: Use automatic feed to perform drill press operation to blueprint specifications.

Standard:
1. All activities on the Performance Checklist must be rated by your instructor as satisfactorily performed.
2. Operations must be performed to blueprint specifications.

---

### Learning Activities

1. Read manufacturer's operation manual.

2. Attend demonstration by instructor:

   a. Calculating feed.
   b. Setting up automatic drill press.

3. In Safety Notebook, write:

   a. Three (3) personal safety practices.
   b. Three (3) general shop safety practices.

4. Practice setting up automatic drill press.

5. Obtain job work order from instructor:

    a. Obtain material, tools, and safety equipment.
    b. Lay out work piece to specifications.
    c. Set up automatic drill press.
    d. Align work piece.
    e. Calculate speed and feed.
    f. Have instructor check set-up.
    g. Drill work piece.
    h. Clean up work area.
    i. Submit work piece to instructor for evaluation.

# UNIT VI

## OPERATING POWER SAWS

### Terminal Objectives

Upon completion of the modules in this unit, you will be able to:

- Perform preventive maintenance on a bandsaw
- Perform preventive maintenance on a power hacksaw
- Determine the type of steel to be sawed, according to specifications
- Select appropriate blades for sawing
- Remove and replace saw blades
- Select and set speeds and feeds for sawing operations
- Cut and weld bandsaw blades to insert for contour sawing
- Measure material and cut off material with a power hacksaw
- Saw, with a metal bandsaw, to scribed lines

## Student Competency Sheet

Unit VI: OPERATING POWER SAWS

Module A: Setting Up

Task 1: DETERMINE TYPE OF STEEL TO BE SAWED

---

### Performance Checklist

1. Identify piece of steel by color code chart.
2. Have identification of steel piece checked and approved.
3. If using spark test:
    a. Observe all safety practices.
    b. Compare spark pattern to chart.
    c. Have identification of steel piece checked and approved.

### Test

| | |
|---|---|
| Items Needed: | 1. Tool or hand grinder<br>2. Color code chart<br>3. Pieces of steel stock |
| Task: | 1. Use color code to identify type of steel to be sawed.<br>2. Use spark test to identify type of steel to be sawed. |
| Standard: | Steel must be identified correctly. |

---

### Learning Activities

1. Read one (1) of the following:

    a. Machining Fundamentals (Walker), pp. 369-370.
    b. Metalwork Technology and Practices (Ludwig/McCarthy), pp. 147-154.

2. Attend lecture-demonstration by instructor:

    a. Color coding of steel.
    b. Spark test to determine carbon content of steel.

3. In Safety Notebook, write three (3) personal safety practices for doing a spark test.

4. Make up a chart of color codes for steel identifications.

5. Define and discuss qualities and uses of low, medium, and high carbon steel.

6. Practice doing spark test to identify steel.
7. Obtain test pieces from instructor; determine type of steel.
8. Have your instructor check your identifications.

# Student Competency Sheet

Unit VI: OPERATING POWER SAWS

Module A: Setting Up

Task 2: SELECT APPROPRIATE BLADES

---

## Performance Checklist

1. Identify kind of material of work piece to be sawed.
2. Identify shape and thickness of work piece.
3. Select, from reference table, blade requirements of appropriate pitch.
4. Determine needed length, width, and thickness of blade.
5. Select appropriate blade.

## Test

Items Needed:
1. Work piece
2. Job specifications
3. Reference handbook
4. Selection of saw blades

Task: Select the appropriate blade to perform the specified sawing operations.

Standard: All activities on the attached Check Sheet must be rated acceptable by your instructor.

---

## Learning Activities

1. Read two (2) of the following:
    - a. Machining Fundamentals (Walker), pp. 129 and 132.
    - b. Machinists Library; Basic Machine Shop (Black), p. 13.
    - c. Metalwork Technology and Practices (Ludwig/McCarthy), pp. 93 and 98.
2. Attend lecture by instructor on selecting power hack saw blades.
3. Write definitions for:
    - a. Flexible back blades
    - b. All hard blades
    - c. Raker set
    - d. Wavy set
    - e. Standard tooth
    - f. Skip tooth
    - g. Hook tooth

4. Obtain work piece to be sawed:

   a. Identify shape, thickness, and type of metal.
   b. Identify blade requirements.
   c. Select appropriate blade.
   d. Submit selection to instructor for evaluation.

INSTRUCTOR CHECK SHEET - SELECTION OF POWER SAW BLADE

| ACTIVITIES | | RATING* | |
|---|---|---|---|
| | | ACCEPTABLE | NOT ACCEPTABLE |
| 1. Identified metal to be cut: | material | | |
| | shape | | |
| | thickness | | |
| 2. Identified blade pitch. | | | |
| 3. Identified blade requirements: | length | | |
| | width | | |
| | thickness | | |
| 4. Selected appropriate blade. | | | |

*All activities should be rated acceptable.

# Student Competency Sheet

Unit VI: OPERATING POWER SAWS

Module A: Setting Up

Task 3: REMOVE AND REPLACE SAW BLADES

---

## Performance Checklist

### Power Hacksaw

1. Select appropriate saw blade.
2. Cut off all electrical power.
3. Release tension clamp.
4. Remove and store blade.
5. Adjust for length of new blade.
6. Insert new blade in frame.
7. Insure that teeth point in direction of cut to be done.
8. Tighten blade in the frame.

### Metal Bandsaw

1. Select appropriate saw blade.
2. Cut off all electrical power.
3. Release tension on blade.
4. Remove blade.
5. Loop blade for storage.
6. Check guides, and remove and install new guides, if necessary.
7. Unwind new blade.
8. Install new blade.
9. Apply proper tension to blade; inspect for blade direction and guide seating.

## Test

Items Needed:
1. Power hacksaw
2. Metal bandsaw
3. Blades
4. Hand tools
5. Reference handbook

Task:
1. Remove saw blades.
2. Replace saw blades.

Standard:
1. Your instructor must approve your performance of each removal activity in the Performance Checklist.
2. Your instructor must approve your performance of each replacement activity in the Performance Checklist.
3. All items on Instructor Check Sheet must be rated acceptable.

---

## Learning Activities

1. Read one (1) of the following:

   a. Machining Fundamentals (Walker), pp. 129-130 and 132.
   b. Metalwork Technology and Practices (Ludwig/McCarthy), pp. 90 and 98.

2. Observe demonstrations by instructor:

   a. Removing blade from power hacksaw.
   b. Installing blade on power hacksaw.
   c. Removing blade from metal bandsaw.
   d. Installing blade on metal bandsaw.
   e. Storage of metal bandsaw blade.

3. In Safety Notebook, write:

   a. Five (5) personal safety practices.
   b. Five (5) general shop safety practices.

4. Practice installing blades on power hacksaws and metal bandsaws.

5. Obtain blade from instructor for power hacksaw:

   a. Obtain safety equipment.
   b. Obtain needed hand tools for installation.
   c. Install blade; set tension.
   d. Have instructor inspect work.
   e. Return tools to storage area.

6. Obtain blade from instructor for metal bandsaw.

   a. Obtain safety equipment.
   b. Obtain needed hand tools for installation.
   c. Install blade; set tension.
   d. Have instructor inspect work.
   e. Return tools to storage area.

INSTRUCTOR CHECK SHEET - REMOVING/REPLACING SAW BLADES

| ACTIVITIES | RATING | |
|---|---|---|
| | ACCEPTABLE | NOT ACCEPTABLE |
| A. POWER HACKSAW | | |
| 1. Selected correct safety equipment. | | |
| 2. Selected correct hand tools needed. | | |
| 3. Removed old blade correctly. | | |
| 4. Installed blade correctly:<br>a. Teeth facing correctly. | | |
| b. Tension correct. | | |
| 5. Cleaned up area and returned tools. | | |
| B. METAL BAND SAW<br>1. Selected correct safety equipment. | | |
| 2. Selected correct hand tools needed. | | |
| 3. Removed old blade correctly. | | |
| 4. Looped blade for storage. | | |
| 5. Checked guides. | | |
| 6. Uncoiled new blade safely. | | |
| 7. Installed new blade correctly. | | |
| 8. Set tension correctly. | | |
| 9. Cleaned up area and returned tools. | | |

# Student Competency Sheet

## Unit VI: OPERATING POWER SAWS

### Module A: Setting Up

### Task 4: SELECT AND SET SPEEDS AND FEEDS FOR SAWING OPERATIONS

---

Performance Checklist

1. Determine material to be sawed.
2. Determine type of saw to be used.
3. Determine speed and feed requirements.
4. Set machine speed and feed according to manufacturer's operation manual.

Test

Items Needed:

1. Job specifications
2. Description of work piece
3. Manufacturer's operation manual
4. Machinery handbook

Task:

1. Select speed and feed for the specified sawing operation.
2. Set speed and feed for the specified sawing operation.

Standard:

1. Speeds and feeds must be precisely set, as specified in the machinery handbook for the workpiece described.
2. Your instructor must approve your selection and the set-up in accordance with handbook specifications.

---

Learning Activities

1. Read two (2) of the following:
   a. Machining Fundamentals (Walker), pp. 127-133.
   b. Machinists Library (Black), pp. 11-15.
   c. Metalwork Technology and Practices (Ludwig/McCarthy), pp. 90-99.
2. Attend lecture-demonstration by instructor:
   a. Selecting cutting speed
   b. Selecting feed rate
   c. Setting cutting speed
   d. Setting feed rate

3. In class notebook, write notes from readings and lecture-demonstration.

4. In Safety Notebook, write:

   a. Five (5) personal safety practices.
   b. Ten (10) general shop safety practices.

5. Discuss metal properties and other conditions that require different speed and feed rates.

6. Determine the cutting speed for cutting low carbon steel on a power hacksaw and on a metal bandsaw.

7. Using a cutting speed chart for power hacksaw and metal bandsaw, determine speed for the following:

   a. Aluminum
   b. Brass
   c. Cast iron
   d. Copper
   e. Low carbon steel
   f. Medium carbon steel
   g. Tool steel

8. Obtain a sample piece of metal:

   a. Identify the metal.
   b. Use speed chart; determine correct speed.
   c. Set the saw for correct cutting speed.
   d. Set the saw for correct feed.
   e. Instructor will evaluate set-up.

INSTRUCTOR CHECK SHEET -
SETTING SPEED AND FEED FOR POWER HACKSAW AND METAL BANDSAW

| ACTIVITIES | RATING | |
|---|---|---|
| | ACCEPTABLE | NOT ACCEPTABLE |
| 1. Selected safety equipment. | | |
| 2. Determined type of metal correctly. | | |
| 3. Interpreted speed chart correctly. | | |
| 4. Interpreted feed chart correctly. | | |
| 5. Set speed correctly. | | |
| 6. Set feed correctly. | | |
| 7. Cleaned up work area. | | |
| | | |
| | | |
| | | |
| | | |

# Student Competency Sheet

Unit VI: OPERATING POWER SAWS

Module A: Setting Up

Task 5: CUT AND WELD BANDSAW BLADES TO INSERT FOR CONTOUR SAWING

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## Performance Checklist

1. Cut off electrical power to saw.
2. Release blade tension.
3. Cut blade.
4. Insert blade properly through workpiece.
5. Butt weld blade.
6. Anneal weld point.
7. Grind weld.
8. Remount blade and adjust blade tension.

## Test

Items Needed:
1. Machinery reference manual
2. Drilled work piece
3. Bandsaw with butt welder and grinder system

Task: Cut and then weld a bandsaw blade for contour sawing.

Standard: The weld must meet specifications outlined in the reference manual.

---

## Learning Activities

1. In the manufacturer's manual, read sections on welding and grinding blades.

2. Observe a demonstration by the instructor.

3. In Safety Notebook, write:

   a. Five (5) personal safety practices.
   b. Three (3) general shop safety practices.
   c. List safety equipment needed.

4. Practice welding and grinding sections of broken or old blades.

5. In class notebook, write an outline of the procedure for welding and grinding metal bandsaw blades.

6. Select a work sheet for a project with an internal cut:

   a. Select safety equipment.
   b. Drill work piece for inserting blade.
   c. Remove blade from metal bandsaw.
   d. Insert blade through work.
   e. Weld, anneal weld, and grind weld.
   f. Have instructor inspect weld of blade.
   g. Remount blade; set tension.
   h. Cut project.
   i. Cut blade and remove from work.
   j. Weld, anneal, and grind weld.
   k. Remount blade on saw; set tension.
   l. Clean machine and surrounding area.
   m. Have instructor inspect your work.

INSTRUCTOR CHECK SHEET -- CUT AND WELD BANDSAW BLADES

| ACTIVITIES | RATING | |
|---|---|---|
| | ACCEPTABLE | NOT ACCEPTABLE |
| 1. Selected correct safety equipment. | | |
| 2. Drilled hole in work large enough for blade | | |
| 3. Cut blade at correct point. | | |
| 4. Butt welded correctly. | | |
| 5. Annealed blade correctly. | | |
| 6. Ground blade correctly. | | |
| 7. Mounted blade correctly. | | |
| 8. Set blade tension correctly. | | |
| 9. Cut work correctly and safely. | | |
| 10. Cut blade at correct point. | | |
| 11. Welded blade correctly. | | |
| 12. Annealed weld correctly. | | |
| 13. Ground weld correctly. | | |
| 14. Installed blade correctly. | | |
| 15. Cleaned up machine and work area. | | |
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# Student Competency Sheet

Unit VI: OPERATING POWER SAWS

Module B: Cutting

Task 1: MEASURE MATERIAL AND CUT OFF MATERIAL WITH POWER HACKSAW

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## Performance Checklist

### Measure and Mark Material

1. Refer to job specifications for dimensions.
2. Measure to dimensions.
3. Mark location with file/scribe.

### Cut Off Material

1. Secure material in saw vise; support with floor stand, if necessary.
2. Lower saw to work.
3. Adjust material to required length (allow 1/16" for saw cut).
4. Lock material in vise.
5. Adjust gauge or stop, if required.
6. Lower saw to material to be sawed.
7. Adjust coolant nozzle.
8. Saw to specifications (allow + 1/16" tolerance).

## Test

Items Needed:
1. Fully equipped power hacksaw
2. Job specifications
3. Work piece
4. Steel rule
5. File
6. Scribe
7. Saw vise
8. Floor stand

Task:
1. Measure material.
2. Cut off material with power hack saw.

Standard: Material must be measured and cut to + 1/16" accuracy.

---

## Learning Activities

1. Read two (2) of the following:
   a. Machine Shop Operations and Setups (Porter/Lascoe/Nelson), pp. 67-77.
   b. Machining Fundamentals (Walker), pp. 127-134.

    c. Machinists Library (Black), pp. 11-15.
    d. Metalwork Technology and Practices (Ludwig/McCarthy), pp. 90-100.

2. Observe demonstration by instructor:

    a. Layout of project.
    b. Use of power hacksaw.

3. In Safety Notebook, write:

    a. List of safety equipment.
    b. Five (5) personal safety practices.
    c. Five (5) general shop safety practices.

4. Practice layout and cutting on scrap or waste material.

5. Obtain job work order from instructor:

    a. Select safety equipment.
    b. Select material and tools.
    c. Lay out job to specification and satisfaction of instructor.
    d. set up power hacksaw; perform cut.
    e. Clean up machine, area, and tools.
    f. Submit project to instructor for evaluation.

INSTRUCTOR CHECK SHEET - MEASURE MATERIAL AND CUT OFF ON POWER HACKSAW

| ACTIVITIES | RATING | |
|---|---|---|
| | ACCEPTABLE | NOT ACCEPTABLE |
| 1. Selected correct safety equipment. | | |
| 2. Selected material specified. | | |
| 3. Used correct layout tools. | | |
| 4. Dimensioned according to specifications. | | |
| 5. Secured work to saw vise. | | |
| 6. Adjusted saw:<br>a. Correct blade tension | | |
| b. Correct speed | | |
| c. Correct rate of feed | | |
| 7. Operated machine correctly. | | |
| 8. Cut work to specifications. | | |
| 9. Cleaned work area. | | |
| 10. Returned tools to correct storage. | | |

# Student Competency Sheet

## Unit VI: OPERATING POWER SAWS

### Module B: Cutting

### Task 2: SAW WITH A METAL BANDSAW TO SCRIBED LINES

---

Performance Checklist

1. Insure that scribed lines are clear.
2. Mount and align machine guide (if applicable).
3. Insure that correct blade is on saw; make necessary corrections.
4. Determine and set correct cutting speed.
5. Adjust and clamp saw guide.
6. Select and secure appropriate holding device (if necessary).
7. Perform sawing operation:
    a. Support work piece, if necessary.
    b. Align scribed line to blade.
    c. Advance work piece into saw, with steady pressure.
    d. Saw to specifications.

Test

Items Needed:
1. Job specifications
2. Work piece
3. Metal bandsaw with accessories
4. Holding and supporting devices
5. Measurement instruments

Task: Use metal bandsaw to saw work piece to scribed lines and job specifications.

Standard: Work piece must be sawn on scribed lines to job specifications.

---

Learning Activities

1. Read one (1) of the following:
    a. Machining Fundamentals (Walker), p. 127-134.
    b. Metalwork Technology and Practices (Ludwig/McCarthy), pp. 90-100.

2. Observe demonstrations by instructor:

    a. Setting up a metal bandsaw.
    b. Cutting on metal bandsaw with a vise.
    c. Free-hand cutting to a scribed line on a metal bandsaw.

3. In Safety Notebook, write:

    a. Ten (10) personal safety practices.
    b. Five (5) general shop safety practices.

4. Practice cutting on metal bandsaw (use scrap or waste metal).

5. Obtain a job work order from instructor:

    a. Select safety equipment.
    b. Select material and tools.
    c. Lay out work according to the specifications.
    d. Set up metal bandsaw to correct speed.
    e. Check blade tension.
    f. Mount work in vise (if a vise is to be used).
    g. Cut work to scribed lines.
    h. Clean up bandsaw and tools.
    i. Submit project to instructor for evaluation.

INSTRUCTOR CHECK SHEET - SAWING WITH A METAL BANDSAW TO A SCRIBED LINE

| | RATING | |
|---|---|---|
| ACTIVITIES | ACCEPTABLE | NOT ACCEPTABLE |
| 1. Utilized correct safety equipment. | | |
| 2. Selected specified material. | | |
| 3. Selected correct lay out tools. | | |
| 4. Project laid out to specifications. | | |
| 5. Set-up of metal bandsaw: | | |
| a. Correct speed | | |
| b. Correct feed | | |
| c. Correct blade tension | | |
| d. Guides in place | | |
| 6. Secured work correctly. | | |
| 7. Cut work to specifications. | | |
| 8. Work area cleaned and tools returned. | | |
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## Student Competency Sheet

Unit VI: OPERATING POWER SAWS

Module C: Saw Maintenance

Task 1: PERFORM PREVENTIVE MAINTENANCE ON BANDSAW

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Performance Checklist

1. Clean and lubricate.
2. Inspect holding devices.
3. Check band guide for wear and adjustments.
4. Check bandsaw blade for mounting, tension, set, and sharpness.
5. Inspect speed and feed systems for correct functioning.

Test

Items Needed:
1. Manufacturer's operation manual
2. Cleaner
3. Lubricant
4. Feeler gage

Task:
1. Inspect saw for safety and proper operation condition.
2. Clean saw.
3. Lubricate saw according to manufacturer's specifications.
4. Adjust band guide. Allow clearance of 0.001" to 0.002".

Standard:
1. Saw must be in safe and proper operative condition.
2. Saw must be clean.
3. Lubrication must be performed according to manufacturer's specifications.
4. Band guide must be adjusted to allow clearance of 0.001" to 0.002".

---

Learning Activities

1. Read the maintenance section of the manufacturer's manual.

2. Observe demonstrations by instructor:

   a. Cleaning and lubricating bandsaw.
   b. Adjusting guides.
   c. Mounting bandsaw blades.

3. In Safety Notebook, write:

    a. Three (3) personal safety practices.
    b. Three (3) general shop safety practices.

4. Perform a preventive maintenance inspection on a machine that has minor problems:

    a. Write a paper telling what is wrong with machine.
    b. Write corrections to be carried out.

5. Perform preventive maintenance on bandsaw. Have your instructor evaluate your work.

INSTRUCTOR CHECK SHEET - PERFORM PREVENTIVE MAINTENANCE ON METAL BANDSAW

| | RATING | |
|---|---|---|
| ACTIVITIES | ACCEPTABLE | NOT ACCEPTABLE |
| 1. Cleaned machine. | | |
| 2. Lubricated machine. | | |
| 3. Assured that holding device is working correctly. | | |
| 4. Assured that blade guides are in usable condition. | | |
| 5. Assured that blade guides are properly adjusted. | | |
| 6. Inspected blade set and sharpness. | | |
| 7. Assured that blade tension is correct. | | |
| 8. Used proper safety equipment. | | |
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## *Student Competency Sheet*

Unit VI: OPERATING POWER SAWS

Module C: Saw Maintenance

Task 2: PERFORM PREVENTIVE MAINTENANCE ON POWER HACKSAW

---

### Performance Checklist

1. Clean and lubricate.
2. Inspect holding device.
3. Check blade for wear.
4. Check blade tension.
5. Inspect speed system.

### Test

Items Needed:

1. Manufacturer's operational manual
2. Cleaner
3. Lubricant

Task:

1. Inspect saw for safety and proper operating condition.
2. Clean saw.
3. Lubricate saw according to manufacturer's specifications.
4. Adjust blade tension.

Standard:

1. Saw must be in safe and proper operative condition.
2. Saw must be clean.
3. Lubrication must be performed according to manufacturer's specifications.
4. Blade tension must be set correctly.

---

### Learning Activities

1. Read the manufacturer's manual (service and maintenance sections).

2. Observe demonstrations by the instructor:

   a. Cleaning and lubricating the power hacksaw.
   b. Adjusting the blade tension.
   c. Inspecting hold-down device and speed control.

3. In Safety Notebook, write:

   a. Three (3) personal safety practices.
   b. Three (3) general shop safety practices.

4. Perform a preventive maintenance inspection on a machine that has minor problems:
    a. Write on paper what is wrong.
    b. Write the corrections to be performed.

5. Perform preventive maintenance on the power hacksaw.

## INSTRUCTOR CHECK SHEET - PREVENTIVE MAINTENANCE ON POWER HACKSAW

| ACTIVITIES | RATING | |
|---|---|---|
| | ACCEPTABLE | NOT ACCEPTABLE |
| 1. Used proper safety equipment. | | |
| 2. Cleaned machine. | | |
| 3. Lubricated machine. | | |
| 4. Inspected holding device. | | |
| 5. Inspected blade: a. Sharpness | | |
| b. Tension | | |
| 6. Inspected speed control. | | |
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# UNIT VII

# OPERATING LATHES

## Terminal Objectives

Upon completion of the modules in this unit, you will be able to:

- Inspect a lathe for safe operation
- Perform preventive maintenance on a lathe
- Set up an engine lathe
- Align lathe centers by using the approximate method and by accurate measurement
- Set up a lathe for operations
- Set up a tool post grinder
- Set up a lathe and face a work piece held in a chuck
- Machine between centers on a lathe
- Rough cut and finish cut with a lathe
- Cut long external tapered surfaces, using a taper attachment
- Cut short external tapered surfaces, using a compound rest
- Cut internal tapered surfaces
- Perform contour, angular, or radii cuts with a lathe
- Perform filing on a lathe
- Knurl parts with a lathe
- Perform a grinding operation on a lathe
- Perform a spinning operation using a forming tool
- Drill, bore, counterbore, countersink, and ream holes with a lathe
- Die cut threads with a lathe, using die heads and hand threading
- Cut external and internal threads with a lathe
- Tap threads with a lathe and hand tap internal threads
- Rechase threads on a lathe

## Student Competency Sheet

Unit VII: OPERATING LATHES

Module A: Setting Up

Task 1: SET UP ENGINE LATHE

---

Performance Checklist

1. Clean and lubricate lathe.
2. Check all guards.
3. Inspect belt tension and gears.
4. Check carriage movement.
5. Select and secure appropriate work-holding devices.
6. Select and adjust desired speed and feed.
7. Align centers (if applicable).
8. Select and secure proper tool, fixture, or attachment.
9. Secure work piece.
10. Adhere to standard safety measures.
11. Inspect total set-up.

Test

Items Needed:
1. Blueprint
2. Manufacturer's manual
3. Work piece
4. Cleaner
5. Lubricant
6. Lathe tools
7. Fixtures
8. Attachments
9. Lathe and accessories
10. Precision measurement instruments

Task: Set up engine lathe to perform machining operations, according to supervisor's specifications.

Standard:
1. Set up must be according to blueprint specifications.
2. Set up must be performed by following steps of the Performance Checklist.
3. Your instructor must approve the set-up.

---

Learning Activities

I. Read two (2) of the following:

  a. Machine Shop Operation and Setups (Porter/Lascoe/Nelson), pp. 135-240.
  b. Machining Fundamentals (Walker), pp. 135-208.

   c. Machinists Library; Basic Machine Shop (Black), pp. 127-189 and 221-236.
   d. Metalwork Technology and Practices (Ludwig/McCarthy), pp. 462-491.

2. Read the manufacturer's manual.

3. Observe demonstrations by the instructor:

   a. Cleaning and lubricating.
   b. Safety practices.
   c. Set-up and inspection.
   d. Nomenclature of lathe.

4. In Safety Notebook, write:

   a. Ten (10) personal safety practices.
   b. Ten (10) general shop safety practices.
   c. List safety equipment that should be used.

5. Write answers to questions found at the end of the chapters in the books used in Learning Activity Number 1.

6. Study Information Sheet VII-A-1 (Metal Lathe) and then:

   a. Point out parts of a metal lathe in your shop. Give names and functions.
   b. Point out hazards and safety features.

7. Compile a list of fixtures and attachments available for an engine lathe:

   a. Write the function of each.
   b. Demonstrate the set-up of each.

8. Using a checklist, practice setting up an engine lathe.

9. Set up engine lathe according to an operation to be performed, as directed by your instructor. Have your instructor check your work against a check list.

INSTRUCTOR CHECK SHEET - ENGINE LATHE SET-UP

| ACTIVITIES | RATING | |
|---|---|---|
| | ACCEPTABLE | NOT ACCEPTABLE |
| 1. Wore safety equipment. | | |
| 2. Cleaned and lubricated lathe correctly. | | |
| 3. Checked that all guards were in place and functional. | | |
| 4. Set belt tension and speed correctly. | | |
| 5. Mounted work according to operation to be performed. | | |
| 6. Selected proper tools. | | |
| 7. Aligned tool support and rest properly. | | |
| 8. Used fixtures correctly. | | |
| 9. Used attachments correctly. | | |
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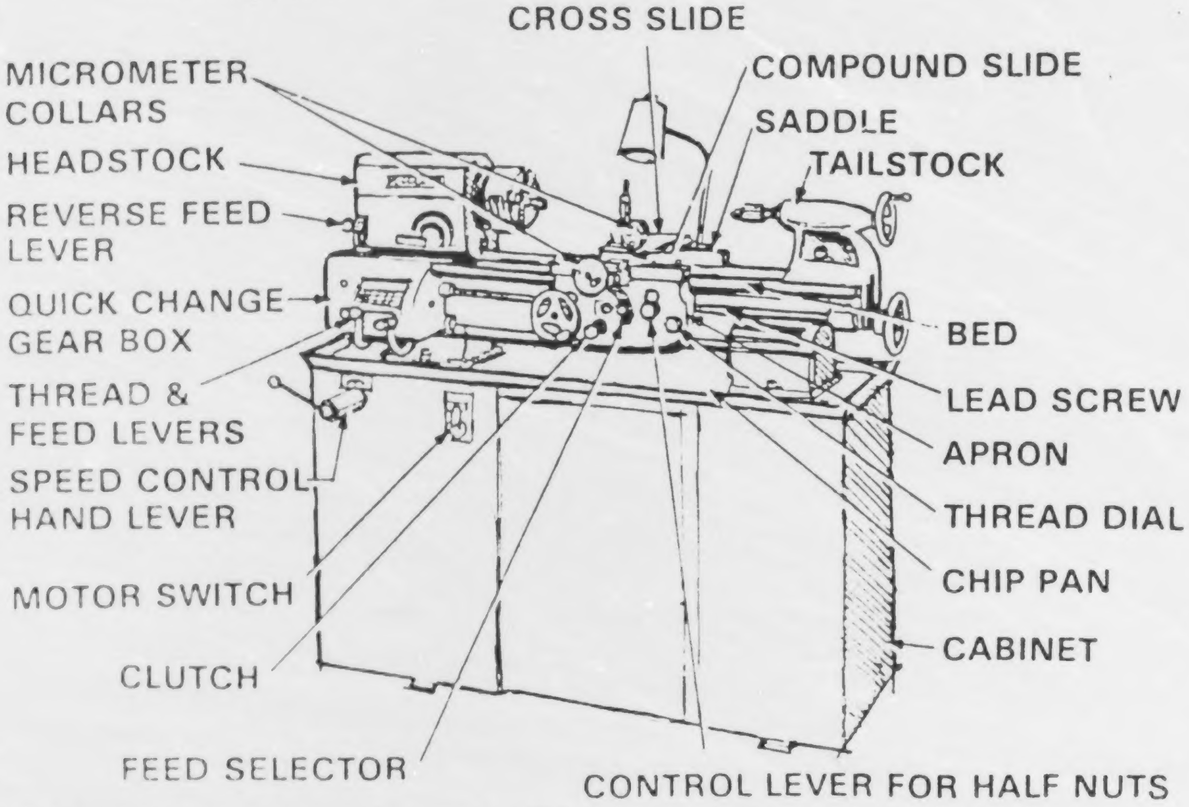
1. Operate only with instructors permission and after you have received instruction.
2. Remove jewelry, eliminate loose clothing, and confine long hair.
3. Make sure all guards are in place and operating correctly.
4. Always use proper eye protection.
5. Never leave the chuck key in the lathe chuck.
6. Rotate spindle by hand to check clearance before engaging power.
7. Remove chips with a brush, never by hand.
8. Make sure work is secure and lathe is set at correct speed and feed before starting cut.
9. Handle chucks and face plates carefully. Never adjust tool bit when tool holder is hand held.
10. Remove tool holder and tool post before filing or polishing.
11. Do not hand stop a lathe chuck, allow it to coast to a stop. Keep hands away from all moving parts.


CROSS SLIDE
MICROMETER COLLARS
COMPOUND SLIDE
SADDLE
TAILSTOCK
HEADSTOCK
REVERSE FEED LEVER
QUICK CHANGE GEAR BOX
BED
THREAD & FEED LEVERS
LEAD SCREW
APRON
SPEED CONTROL HAND LEVER
THREAD DIAL
MOTOR SWITCH
CHIP PAN
CABINET
CLUTCH
FEED SELECTOR
CONTROL LEVER FOR HALF NUTS

Reprinted from: Pennsylvania Industrial Arts Safety Guide, Pennsylvania Department of Education, Industrial Arts Association of Pennsylvania, 1978.

# Student Competency Sheet

## Unit VII: OPERATING LATHES

### Module A: Setting Up

### Task 2: ALIGN LATHE CENTERS USING APPROXIMATE METHOD

---

Performance Checklist

1. Mount centers in headstock and tailstock.
2. Check center alignment.
3. Align centers as needed.

Test

Items Needed:
1. Two (2) dead centers
2. Spindle adaptor
3. Lathe wrenches

Task: Align lathe centers so that both points are in the same horizontal and vertical planes.

Standard: Your instructor must inspect and approve the alignment.

---

Learning Activities

1. Read one (1) of the following:
    a. Machining Fundamentals (Walker), pp. 157-158.
    b. Machinists Library; Basic Machine Shop (Black), pp. 161-162.
    c. Metalwork Technology and Practices (Ludwig/McCarthy), pp. 480-481.
2. Read the manufacturer's manual on aligning lathe centers.
3. Observe demonstration of aligning center by approximate method.
4. Practice aligning centers.
5. Align centers by approximate method; have instructor evaluate alignment.

## Student Competency Sheet

Unit VII: OPERATING LATHES

Module A: Setting Up

Task 3: ALIGN LATHE CENTERS USING ACCURATE MEASUREMENT

---

Performance Checklist

1. Mount cleaned centers in headstock and tailstock.
2. Secure drill rod test bar between centers.
3. Mount dial indicator.
4. Check center alignment.
5. Make necessary adjustments.

Test

Items Needed:
1. Two (2) dead centers
2. Spindle adaptor
3. Drill rod test bar
4. Dial indicator
5. Lathe wrenches

Task: Align lathe centers to within a tolerance of ±0.0005".

Standard: Lathe centers must be aligned to within a tolerance of ±0.0005".

---

Learning Activities

1. Read one (1) of the following:
   a. Machining Fundamentals (Walker), pp. 157-158.
   b. Machinists Library; Basic Machine Shop (Black), pp. 161-162.

2. Read the manufacturer's manual for aligning lathe centers with dial indicator gauge.

3. Observe demonstrations by instructor:
   a. Mounting dial indicator on tool post.
   b. Mounting test rod between centers.
   c. Using dial indicator to align centers.

4. Practice setting centers with dial indicator.

5. Align center with dial indicator; have instructor evaluate your alignment.

INSTRUCTOR CHECK SHEET - ALIGNING LATHE CENTER WITH DIAL INDICATOR

| ACTIVITIES | RATING | |
|---|---|---|
| | ACCEPTABLE | NOT ACCEPTABLE |
| 1. Used proper safety equipment. | | |
| 2. Cleaned lathe. | | |
| 3. Mounted test rod properly. | | |
| 4. Set lathe speed correctly. | | |
| 5. Mounted dial indicator to tool post correctly. | | |
| 6. Used proper tools to set tail stock. | | |
| 7. Aligned lathe centers correctly. | | |
| 8. Returned tools to proper storage. | | |
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# Student Competency Sheet

Unit VII: OPERATING LATHES

Module A: Setting Up

Task 4: SET-UP TURRET LATHE FOR OPERATIONS

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## Performance Checklist

1. Clean and lubricate lathe.
2. Check all guards.
3. Inspect belt tension and gears.
4. Check carriage movement.
5. Select and secure appropriate work-holding devices.
6. Select and adjust desired speed and feed.
7. Select proper tools, fixtures, or attachments.
8. Insert and position tools in turret.
9. Secure work piece.
10. Adhere to standard safety measures.
11. Inspect total set-up.

## Test

Items Needed:

1. Blueprint
2. Manufacturer's manual
3. Work piece
4. Lathe
5. Tools
6. Fixtures
7. Attachments
8. Turret lathe and accessories
9. Precision measurement instruments

Task: Set up turret lathe to machine the work piece according to blueprint specifications.

Standard:

1. Set up must be according to blueprint specifications.
2. Set up must be performed by following all steps in the Performance Checklist.
3. Your instructor must approve the set-up.

---

## Learning Activities

1. Read one (1) of the following:
   a. Machining Fundamentals (Walker), pp. 200-201.
   b. Machinists Library; Basic Machine Shop (Black), pp. 237-252.

2. Read the manufacturer's manual.

3. Observe demonstrations by the instructor:

   a. Setting up turret lathe.
   b. Setting up turret system.
   c. Turret lathe safety procedures.

4. In Safety Notebook, write:

   a. Ten (10) personal safety practices.
   b. Ten (10) general shop safety practices.
   c. List of safety equipment.

5. Explain the difference between an engine lathe and a turret lathe to your instructor.

6. Set up a turret lathe according to job operation sheet; have your instructor check your work against the Check Sheet.

INSTRUCTOR CHECK SHEET - SET-UP TURRET LATHE

| ACTIVITIES | RATING | |
|---|---|---|
| | ACCEPTABLE | NOT ACCEPTABLE |
| 1. Wore safety equipment. | | |
| 2. Cleaned and lubricated lathe. | | |
| 3. Assured that all guards are in place and functional. | | |
| 4. Set belt tension and speed correctly. | | |
| 5. Mounted work correctly and securely. | | |
| 6. Turret head is properly equipped:<br>#1 | | |
| #2 | | |
| #3 | | |
| #4 | | |
| #5 | | |
| #6 | | |

## Student Competency Sheet

Unit VII: OPERATING LATHES

Module A: Setting Up

Task 5: SET-UP TOOL POST GRINDER

---

### Performance Checklist

1. Check wheel for cracks (replace if cracked).
2. Mount tool post grinder.
3. Cover and protect V-ways with cloth.
4. Protect lathe spindle bearing.
5. Dress and true grinding wheel.

### Test

Items Needed:
1. Blueprint
2. Lathe and accessories
3. Tool post grinder
4. Grinding wheel
5. Diamond point dresser

Task: Set-up tool post grinder.

Standard:
1. Set-up must be performed by following all steps in the Performance Checklist.
2. Your instructor must approve the set-up.

---

### Learning Activities

1. Read one (1) of the following:
    a. Machining Fundamentals (Walker), pp. 196-198.
    b. Machinists Library; Basic Machine Shop (Black), p. 233.

2. Read the manufacturer's manual for the grinding attachment.

3. Observe demonstrations by instructor:
    a. Setting up a tool post grinder.
    b. Mounting work for grinding.
    c. External grinding on lathe.
    d. Internal grinding on lathe.
    e. Dressing grinding wheel.
    f. Grinding wheel safety practices.

4. In Safety Notebook, write:
    - a. Ten (10) personal safety practices.
    - b. Ten (10) general shop safety practices.
    - c. List safety equipment to be used.
5. Practice setting up a tool post grinding attachment.
6. Set up a tool post grinder on an engine lathe; have instructor evaluate your set-up.

INSTRUCTOR CHECK SHEET - SETTING UP TOOL POST GRINDER

| | RATING | |
|---|---|---|
| ACTIVITIES | ACCEPTABLE | NOT ACCEPTABLE |
| 1. Used appropriate safety equipment. | | |
| 2. Cleaned and lubricated lathe. | | |
| 3. Assured that all guards in place and functional. | | |
| 4. Set speed and feed correctly. | | |
| 5. Secured work properly. | | |
| 6. Secured tool post grinder properly. | | |
| 7. Aligned tool post grinder correctly. | | |
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# Student Competency Sheet

Unit VII: OPERATING LATHES

Module B: Cutting

Task 1: SET UP LATHE AND FACE WORK PIECE HELD IN A CHUCK

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## Performance Checklist

### Three-Jaw Universal Chuck

1. Clean and lightly oil threads on lathe spindle.
2. Clean threads in chuck.
3. Mount chuck on lathe spindle.
4. Mount work piece in chuck:
   a. Check for true running.
   b. Shim to allow true running (if necessary).
5. Mount regular turning tool in tool holder.
6. Adjust angle of tool holder and turning tool.
7. Center tool to center of work piece.
8. Lock carriage to the bed.
9. Select and set speed and feed:
   a. Hand feed small pieces.
   b. Use automatic feed for large diameter pieces.
10. Face material, removing 1/16" to 1/8".
11. Check to insure ends are faced square to the axis of the work.

### Four-Jaw Independent Chuck

1. Repeat steps one (1) to three (3) listed under Three-Jaw Universal Chuck.
2. Adjust work piece in chuck, using dial indicator.
3. Repeat steps five (5) to eleven (11) listed under Three-Jaw Universal Chuck.

### Collet Chuck (commonly used on work 1" diameter or less)

1. Clean and lightly oil the nose of the lathe spindle.
2. Repeat steps one (1) to three (3) listed under Three-Jaw Universal Chuck.
3. Repeat steps five (5) to eleven (11) listed under Three-Jaw Universal Chuck.

## Test

Items Needed:
1. Lathe and accessories
2. Rags
3. Light oil
4. Three-Jaw Universal Chuck
5. Shims
6. Collet Chuck
7. Four-Jaw Independent Chuck
8. Chuck key
9. Reference handbook
10. Square
11. Work piece
12. Regular facing tool
13. Cutters

Task:

1. Use three-jaw universal chuck to face work piece until ends of work piece are faced square to axis of work.
2. Use four-jaw independent chuck to face work piece until ends of work piece are faced square to axis of work.
3. Use collet chuck to face work piece until ends of work piece are faced square to axis of work.
4. Face 1/16" to 1/8" in facing operations.

Standard:

1. Facing operation must remove 1/16" to 1/8" from work piece.
2. Ends of work piece must be square to axis of work.

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## Learning Activities

1. Read two (2) of the following:

    a. Machining Fundamentals (Walker), pp. 142-171.
    b. Machinists Library; Basic Machine Shop (Black), pp. 140-149 and 164-166.
    c. Metalwork Technology and Practices (Ludwig/McCarthy), pp. 462-480.

2. Observe demonstrations by instructor:

    a. Mounting three-jaw universal chuck on lathe.
    b. Mounting work in a three-jaw universal chuck.
    c. Centering work with shims in a three-jaw universal chuck.
    d. Mounting four-jaw independent chuck on a lathe.
    e. Mounting dial indicator on tool post.
    f. Mounting work in a four-jaw independent chuck.
    g. Mounting collet chuck on lathe.
    h. Mounting work in a collet chuck.
    i. Mounting cutter in tool holder and setting tool holder.
    j. Selecting feeds and speeds for face cutting.
    k. Facing work by hand feed.
    l. Facing work by automatic feed.

3. In Safety Notebook, write:

    a. Ten (10) personal safety practices.
    b. Ten (10) general shop safety practices.

4. Research the different types of collet systems that are available.

5. Practice setting up work in, and cutting tool for:

    a. Three-jaw universal chuck.
    b. Four-jaw independent chuck.
    c. Collet chuck system.

6. Set up work for evaluation by instructor:

   a. Work mounted in three-jaw universal chuck.
   b. Work mounted in a four-jaw independent chuck.
   c. Work mounted in a collet chuck system.
   d. Have instructor evaluate your performance.

INSTRUCTOR CHECK SHEET - SET-UP LATHE AND FACE WORK PIECE HELD IN CHUCK

| ACTIVITIES | RATING | |
|---|---|---|
| | ACCEPTABLE | NOT ACCEPTABLE |
| A. THREE-JAW UNIVERSAL CHUCK | | |
| 1. Utilized safety equipment. | | |
| 2. Mounted three-jaw universal chuck correctly. | | |
| 3. Mounted work correctly. | | |
| 4. Locked carriage to bed. | | |
| 5. Positioned tool post correctly. | | |
| 6. Positioned correct tool rest. | | |
| 7. Positioned correct cutter. | | |
| 8. Set lathe speed correctly. | | |
| 9. Set hand feed. | | |
| 10. Set automatic feed correctly. | | |
| 11. Set depth of cut correctly. | | |
| 12. Work faced at right angle to axis of work. | | |
| 13. Cleaned work area. | | |
| 14. Released tension on lathe drive. | | |
| B. FOUR-JAW INDEPENDENT CHUCK | | |
| 1. Utilized safety equipment. | | |
| 2. Four-jaw independent chuck mounted correctly. | | |
| 3. Mounted work correctly. | | |
| 4. Locked carriage to bed. | | |
| 5. Positioned tool post correctly. | | |
| 6. Positioned correct tool rest. | | |

INSTRUCTOR CHECK SHEET - SET-UP LATHE AND FACE WORK PIECE HELD IN CHUCK

|  | RATING |  |
|---|---|---|
| ACTIVITIES | ACCEPTABLE | NOT ACCEPTABLE |
| B. FOUR-JAW INDEPENDENT CHUCK (Continued) |  |  |
| 7. Positioned correct cutter. |  |  |
| 8. Set lathe speed correctly. |  |  |
| 9. Set hand feed. |  |  |
| 10. Set automatic feed correctly. |  |  |
| 11. Set depth of cut correctly. |  |  |
| 12. Work faced at right angle to axis of work. |  |  |
| 13. Cleaned work area. |  |  |
| 14. Released tension on lathe drive. |  |  |
| C. COLLET CHUCK SYSTEM |  |  |
| 1. Utilized safety equipment. |  |  |
| 2. Collet chuck system mounted correctly. |  |  |
| 3. Mounted work correctly. |  |  |
| 4. Locked carriage to bed. |  |  |
| 5. Positioned tool post correctly. |  |  |
| 6. Positioned correct tool rest. |  |  |
| 7. Positioned correct cutter. |  |  |
| 8. Set lathe speed correctly. |  |  |
| 9. Set hand feed. |  |  |
| 10. Set automatic feed correctly. |  |  |
| 11. Set depth of cut correctly. |  |  |
| 12. Work faced at right angle to axis of work. |  |  |

INSTRUCTOR CHECK SHEET - SET-UP LATHE AND FACE WORK PIECE HELD IN CHUCK

| ACTIVITIES | RATING | |
|---|---|---|
| | ACCEPTABLE | NOT ACCEPTABLE |
| C. COLLET CHUCK SYSTEM (Continued) | | |
| 13. Cleaned work area. | | |
| 14. Released tension on lathe drive. | | |
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# Student Competency Sheet

Unit VII: OPERATING LATHES

Module B: Cutting

Task 2: MACHINE BETWEEN CENTERS ON A LATHE

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## Performance Checklist

1. Read blueprint to obtain finished specifications.
2. Cut stock to correct length.
3. Face ends using a collet, three-jaw chuck, or four-jaw chuck.
4. Center drill ends.
5. Mount work between centers.
6. Set tool rest.
7. Select correct cutter.
8. Machine work to specification of blueprint.

## Test

Items Needed:
1. Blueprint
2. Engine lathe and accessories (cutters, holders, lathe dog).
3. Project stock
4. Center drills
5. Semi precision and precision measuring instruments
6. Safety equipment

Task:
1. To mount work between centers.
2. Machine on lathe to blueprint specifications.

Standard:
1. Finished project must be within specified tolerances.
2. Lathe must be operated correctly and safely.

---

## Learning Activities

1. Read two of the following:
    - a. *Machining Fundamentals* (Walker), pp. 145-171.
    - b. *Machinists Library; Basic Machine Shop* (Black), pp. 157-190.
    - c. *Metalwork Technology and Practices* (Ludwig/McCarthy), pp. 462-463.
2. Observe demonstrations by instructor:
    - a. Facing with collets.
    - b. Facing with three-jaw chuck.
    - c. Facing with four-jaw chuck.

   d. Center drilling on lathe.
   e. Mounting tool rest and tool for cutting.
   f. Cutter bit sharpening and selection.
   g. Mounting work between centers.
   h. Selecting feed and speeds.

3. In Safety notebook, write:

   a. Ten personal safety practices.
   b. Ten general shop safety practices.
   c. Safety equipment needed.

4. Practice setting up work between centers and machining to specifications.

5. Obtain work job blueprint from instructor:

   a. Select safety equipment.
   b. Obtain material for project.
   c. Mount work between centers on lathe.
   d. Machine to specification of blueprint.
   e. Submit finished project to instructor for evaluation.

INSTRUCTOR CHECK SHEET - MACHINING BETWEEN CENTERS ON A LATHE

| ACTIVITIES | RATING | |
|---|---|---|
| | ACCEPTABLE | NOT ACCEPTABLE |
| 1. Used correct safety equipment. | | |
| 2. Selected correct material. | | |
| 3. Selected correct tools. | | |
| 4. Faced work correctly. | | |
| 5. Drilled center holes. | | |
| 6. Checked center alignment. | | |
| 7. Mounted work correctly. | | |
| 8. Compound tool rest set correctly. | | |
| 9. Used correct tool holder for operation. | | |
| 10. Cutter tool mounted correctly. | | |
| 11. Work performed correctly. | | |
| 12. Proper handling of measuring tools. | | |
| 13. Cleaned work area. | | |
| 14. Work turned to specification. | | |
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## Student Competency Sheet

Unit VII: OPERATING LATHES

Module B: Cutting

Task 3: ROUGH CUT AND FINISH CUT WITH LATHE

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### Performance Checklist

1. Identify work piece material.
2. Select and set speed/feeds.
3. Rough cut to specifications.
4. Select and set speed.
5. Finish cut to specifications.

### Test

Items Needed:
1. Work piece (properly mounted)
2. Blueprint
3. Lathe and accessories
4. Cutting tool
5. Precision measurement instruments

Task:
1. Rough cut the work piece within an accuracy of +0.005" to +0.015".
2. Finish cut the work piece within an accuracy of +0.002" for 1/4" diameter work.
3. Finish cut the work piece within +0.007" for a diameter which is 4" or larger.

Standard:
1. Rough cut accuracy must be +0.005" to +0.015".
2. Finish cut accuracy on 1/4" diameter work must be within +0.002" of specifications.
3. Finish cut accuracy on 4" or larger diameter work must be within +0.007" of specifications.

---

### Learning Activities

1. Read two of the following:

   a. Machining Fundamentals (Walker), pp. 139-152.
   b. Machinists Library; Basic Machine Shop (Black), pp.157-190.
   c. Metalwork Technology and Practices (Ludwig/McCarthy), pp. 462-480.

2. Observe demonstration by instructor:

   a. Mounting work on engine lathe.
   b. Setting up engine lathe.
   c. Selecting feed and speed for rough cutting.
   d. Selecting feed and speed for finish cutting.

3. In Safety Notebook, write:
    a. Five personal safety practices.
    b. Five general shop safety practices.
4. Practice rough cut and finish cut.
5. Obtain job work order:
    a. Set up lathe.
    b. Set speed and feed for rough cut.
    c. Perform work; have instructor check work.
    d. Set speed and feed for finish cut.
    e. Perform work; have instructor check work.
    f. Clean up work area.
    g. Have instructor evaluate work.

INSTRUCTOR CHECK SHEET - ROUGH CUT AND FINISH CUT WITH LATHE

| ACTIVITIES | RATING | |
|---|---|---|
| | ACCEPTABLE | NOT ACCEPTABLE |
| 1. Used safety equipment. | | |
| 2. Mounted work correctly. | | |
| 3. Set tool system correctly. | | |
| 4. Speed correct for rough cut. | | |
| 5. Feed correct for rough cut. | | |
| 6. Machined to specified tolerance +0.005" to +0.015". | | |
| 7. Speed correct for finish cut. | | |
| 8. Feed correct for finish cut. | | |
| 9. Machined to specified tolerance. | | |
| 10. Work area cleaned. | | |
| 11. Tools returned to storage. | | |

## Student Competency Sheet

Unit VII: OPERATING LATHES

Module B: Cutting

Task 4: USING TAPER ATTACHMENT, CUT LONG EXTERNAL TAPERED SURFACES

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Performance Checklist

1. Chuck work piece on lathe.
2. Select and set speed (repeat in steps 3-8 as needed).
3. Face and center drill work piece.
4. Secure work piece between centers.
5. Set taper attachment.
6. Make roughing cut.
7. Measure work piece and make necessary adjustments.
8. Finish cut to specifications.

Test

Items Needed:
1. Blueprint
2. Work piece
3. Lathe with taper attachment and accessories
4. Precision measurement instruments
5. Combination drill and countersink
6. Cutting tool

Task: Use taper attachment on lathe to cut long external taper to blueprint specifications.

Standard: The cut must be finished to blueprint specifications.

---

Learning Activities

1. Read two of the following:

   a. Machining Fundamentals (Walker), pp. 177-179.
   b. Machinists Library ; Basic Machine Shop (Black), pp.226-229.
   c. Metalwork Technology and Practices (Ludwig/McCarthy), pp. 483-485.

2. Observe demonstration by instructor:

   a. Calculating taper.
   b. Setting up taper attachment.
   c. Cutting taper with taper attachment.

3. In Safety Notebook, write:
    a. Five personal safety practices.
    b. Five general shop safety practices.
4. Research tailstock setover technique of cutting taper:
    a. Write a report.
    b. Set up lathe and cut taper using this technique.
    c. Give a demonstration to class on technique.
5. Practice using taper attachment.
6. Obtain blueprint or work order from instructor:
    a. Select safety equipment.
    b. Obtain material.
    c. Mount work on lathe.
    d. Set up taper attachment.
    e. Perform operation.
    f. Submit work to instructor for evaluation.

## INSTRUCTOR CHECK SHEET - TAPER ATTACHMENT - LONG EXTERNAL TAPERED SURFACE

| ACTIVITIES | RATING | |
|---|---|---|
| | ACCEPTABLE | NOT ACCEPTABLE |
| 1. Safety equipment used. | | |
| 2. Selection of material. | | |
| 3. Mounting work on lathe. | | |
| 4. Set-up of tool. | | |
| 5. Feed correct. | | |
| 6. Speed correct. | | |
| 7. Taper attachment set correctly. | | |
| 8. Taper cut to specification. | | |
| 9. Work area cleaned. | | |
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## Student Competency Sheet

Unit VII: OPERATING LATHES

Module B: Cutting

Task 5: USING COMPOUND REST, CUT SHORT EXTERNAL TAPERED SURFACES

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### Performance Checklist

1. Chuck work piece on lathe.
2. Select and set speed (repeat in steps 3-9, as needed).
3. Face and center drill work piece.
4. Secure work piece between centers.
5. Set compound rest to blueprint specifications.
6. Set up tool for cutting.
7. Make roughing cut.
8. Measure work piece and make necessary adjustments.
9. Finish cut to specifications.

### Test

Items Needed:

1. Blueprint
2. Work piece
3. Lathe with accessories
4. Combination drill and countersink
5. Taper gage
6. Cutting tool
7. Precision measurement instruments
8. Taper per foot-corresponding angle chart

Task:

1. Adjust the compound rest.
2. Cut a short external tapered surface to blueprint specifications.

Standard: The cut must be finished to blueprint specifications.

---

### Learning Activities

1. Read two of the following:
   a. Machining Fundamentals (Walker), pp. 171-172.
   b. Machinists Library; Basic Machine Shop (Black), pp.186-187.
   c. Metalwork Technology and Practices (Ludwig/McCarthy), pp. 483-485.

2. Observe demonstration by instructor:
   a. Calculating angle of taper.
   b. Tapering using compound rest.

3. In Safety Notebook, write:
    a. Three personal safety practices.
    b. Three general shop safety practices.
4. Practice cutting external taper with compound rest.
5. Obtain work order from instructor:
    a. Select safety equipment.
    b. Obtain material specified.
    c. Set up lathe and work.
    d. Perform operation.
    e. Submit project to instructor for evaluation.
    f. Clean up work area.

## INSTRUCTOR CHECK SHEET - USING COMPOUND REST, CUT SHORT EXTERNAL TAPER

| ACTIVITIES | RATING | |
|---|---|---|
| | ACCEPTABLE | NOT ACCEPTABLE |
| 1. Safety equipment utilized. | | |
| 2. Work mounted properly. | | |
| 3. Lathe set up correctly. | | |
| 4. Work turned to specifications. | | |
| 5. Cleaned up work area. | | |
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## Student Competency Sheet

Unit VII: OPERATING LATHES

Module B: Cutting

Task 6: CUT INTERNAL TAPERED SURFACES

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Performance Checklist

1. Chuck work piece in lathe.
2. Mount steady rest.
3. True work piece with dial indicator.
4. Select and set speeds (repeat in steps 5-11, as necessary).
5. Center drill work piece.
6. Step-drill to blueprint specifications.
7. Mount boring bar holder and boring bar with tool on compound rest.
8. Adjust lathe taper attachment.
9. Position boring bar and tool to blueprint specifications.
10. Turn taper and check for accuracy.
11. Make adjustments, as necessary.

Test

Items Needed:
1. Blueprint
2. Work piece
3. Steady rest
4. Dial indicator
5. Drill chuck and key
6. Combination drill and countersink
7. Drills
8. Boring bar holder
9. Boring bar with tool
10. Lathe taper attachment

Task: At the lathe, cut internal tapered surface to blueprint specifications.

Standard: The internal tapered surface must be accurate to blueprint specifications.

---

Learning Activities

1. Read two of the following:

   a. Machining Fundamentals (Walker), pp. 171-173.
   b. Machinists Library; Basic Machine Shop (Black), pp.186-187.
   c. Metalwork Technology and Practices (Ludwig/McCarthy), pp. 483-485.

2. Observe demonstrations by instructor:

   a. Calculating taper angle.
   b. Using boring bars.
   c. Step drilling.
   d. Cutting internal taper with compound rest.
   e. Cutting internal taper with taper attachment.

3. In Safety Notebook, write:

   a. Three personal safety practices.
   b. Three general shop safety practices.

4. Practice cutting internal taper:

   a. With compound rest.
   b. With compound rest and boring bar.
   c. With taper attachment.

5. Obtain work order from instructor for internal taper:

   a. Select safety equipment.
   b. Obtain material.
   c. Set up lathe.
   d. Have instructor check set-up.
   e. Perform machining to specification.
   f. Have instructor evaluate work.
   g. Clean up work.

INSTRUCTOR CHECK SHEET - CUT INTERNAL TAPER

| ACTIVITIES | RATING | |
|---|---|---|
| | ACCEPTABLE | NOT ACCEPTABLE |
| 1. Safety equipment utilized. | | |
| 2. Selected material specified. | | |
| 3. Mounted work in lathe. | | |
| 4. Set compound rest. | | |
| 5. Set boring bar. | | |
| 6. Lathe speed set correctly. | | |
| 7. Work machined to specifications. | | |
| 8. Work area cleaned. | | |
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## Student Competency Sheet

Unit VII: OPERATING LATHES

Module B: Cutting

Task 7: PERFORM CONTOUR, ANGULAR, OR RADII CUTS WITH LATHE

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Performance Checklist

1. Secure work piece in lathe.
2. Determine cutting operation.
    a. Set speed
    b. Select cutting tool
    c. Lay out, if necessary
3. Perform cutting operation to specifications.

Test

Items Needed:
1. Blueprint
2. Work piece
3. Lathe and accessories
4. Cutting tool
5. Vernier bevel protractor
6. Radius gauge
7. Hermaphrodite caliper
8. Micrometer caliper
9. Steel rule

Task: Follow blueprint specifications to:
1. Make contour cuts with lathe.
2. Make angular cuts with lathe.
3. Make Radii cuts with lathe.

Standard:
1. Lengths must be ± 1/64" of specifications.
2. Diameter must be accurate to specifications.
3. Angular cuts must be within 5°, ±5'.

---

Learning Activities

1. Read manufacturer's manual:
    a. Contour cutting
    b. Angular cutting
    c. Radii cutting

2. Observe demonstrations by instructor:
    a. Contour cutting
    b. Angular cutting
    c. Radii cutting

3. In Safety Notebook, write:
   - a. Five personal safety practices.
   - b. Five general shop safety practices.

4. Practice:
   - a. Contour cutting.
   - b. Angular cutting.
   - c. Radii cutting.

5. Obtain work order from instructor:
   - a. Select safety equipment.
   - b. Set up lathe.
   - c. Select and mount stock.
   - d. Perform operation.
   - e. Submit work for evaluation.
   - f. Clean up work area.

## Student Competency Sheet

Unit VII: OPERATING LATHES

Module C: Finishing Operation

Task 1: PERFORM LATHE FILING

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### Performance Checklist

1. Follow safety practices.
2. Secure work piece in lathe.
3. Select and set speed.
4. Select correct file.
5. File to specifications.

### Test

Items Needed:
1. Blueprint
2. Work piece
3. Lathe and accessories
4. Files
5. File handles
6. File card
7. Brush
8. Lubricant
9. Micrometer caliper

Task: Perform lathe filing; remove burrs.

Standard: Filing operation must leave 0.001" for polishing (or according to blueprint specifications).

---

### Learning Activities

1. Read one of the following:
   a. Machining Fundamentals (Walker), pp. 193-194.
   b. Machinists Library; Basic Machine Shop (Black), pp.187-188.
   c. Turning Technology-Engine and Turret Lathes (Krar/Oswald), pp. 87-92.
2. Observe a demonstration by instructor:
   a. File safety
   b. File types and cuts
   c. Using a file on a metal lathe
3. In Safety Notebook, write:
   a. Three personal safety practices when working with files.
   b. Three personal safety practices when using files on lathes.
   c. Three general shop safety practices.

4. Research files:
    a. Write a report on the types of files.
    b. Give a demonstration on files.
5. Practice using files on lathe work.
6. Obtain a work order from the instructor:
    a. Select safety equipment.
    b. Set up lathe.
    c. Select files to be used.
    d. Perform filing operation.
    e. Submit work to instructor for evaluation.
    f. Clean up work area.

## Student Competency Sheet

Unit VII: OPERATING LATHES

Module C: Finishing Operations

Task 2: KNURL PARTS WITH LATHE

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Performance Checklist

1. Select and mount knurling tool.
2. Lay off length of knurl.
3. Position and align knurling tool.
4. Select and set lathe speed.
5. Select and set feed.
6. Knurl and repeat operation until depth of knurl is obtained.
7. Measure diameter.
8. Clean and deburr knurl, if necessary.

Test

Items Needed:
1. Work piece (properly mounted)
2. Blueprint
3. Lathe and accessories
4. Knurling tool
5. Tool holder
6. Scribe
7. Brush
8. Cutting oil
9. Precision measurement instruments

Task: Knurl the work piece to the depth specified on the blueprint.

Standard: From 0.002" to 0.004" to the original diameter must be left.

---

Learning Activities

1. Read one of the following:
    a. Machining Fundamentals (Walker), pp. 191-193.
    b. Machinists Library; Basic Machine Shop (Black), pp.180-181.
    c. Metalwork Technology and Practices (Ludwig/McCarthy) pp. 486-487.
    d. Turning Technology-Engine and Turret Lathes (Krar/Oswald), pp. 93-96.

2. Observe a demonstration by instructor:
    - a. Setting up lathe for knurling.
    - b. Knurling.
3. In Safety Notebook, write:
    - a. Three personal safety practices.
    - b. Three general shop safety practices.
4. Practice knurling on lathe.
5. Obtain work order from instructor:
    - a. Select safety equipment.
    - b. Select material specified.
    - c. Set up lathe for knurling.
    - d. Perform knurling operation.
    - e. Submit project for evaluation.
    - f. Clean up work area.

## INSTRUCTOR CHECK SHEET - KNURLING

| ACTIVITIES | RATING | |
|---|---|---|
| | ACCEPTABLE | NOT ACCEPTABLE |
| 1. Safety equipment used. | | |
| 2. Lathe set up correctly. | | |
| 3. Lathe speed correct. | | |
| 4. Feed setting correct. | | |
| 5. Knurled to specification. | | |
| 6. Cleaned up work area. | | |
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## Student Competency Sheet

Unit VII: OPERATING LATHES

Module C: Finishing Operation

Task 3: PERFORM GRINDING OPERATION

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**Performance Checklist**

1. Secure work piece to lathe.
2. Align mounted and checked grinder to work piece.
3. Protect V-ways grit and dust.
4. Protect lathe spindle bearing.
5. Grind to specifications.
6. Measure for accuracy.

**Test**

Items Needed: 1. Lathe (with properly mounted tool post grinder).
2. Work piece
3. Precision measuring instruments

Task: Use tool post grinder to grind work piece.

Standard: Work piece must be ground to an accuracy of 0.005".

---

**Learning Activities**

1. Read one of the following:
   a. Machining Fundamentals (Walker), pp. 197-198.
   b. Machinists Library; Basic Machine Shop (Black), p.233.
   c. Turning Technology-Engine and Turret Lathes (Krar/Oswald), pp. 225-230.

2. Read the manufacturer's manual for grinding on lathe.

3. Observe demonstration by instructor:
   a. Setting up lathe for grinding.
   b. Setting up a tool post grinder.
   c. Grinding on a metal lathe.

4. In Safety Notebook, write:
   a. Five personal safety practices.
   b. Five general shop safety practices.

5. Practice grinding operation on a lathe.

6. Obtain job work order from instructor:

    a. Select safety equipment.
    b. Select specified material.
    c. Set up lathe for grinding.
    d. Perform grinding operation.
    e. Submit project to instructor.
    f. Clean up work area.

INSTRUCTOR CHECK SHEET - GRINDING OPERATION

| ACTIVITIES | RATING | |
|---|---|---|
| | ACCEPTABLE | NOT ACCEPTABLE |
| 1. Safety equipment utilized. | | |
| 2. Lathe set up correctly. | | |
| 3. Grinder set up correctly. | | |
| 4. Speeds and feed correct. | | |
| 5. Work ground to specifications. | | |
| 6. Work area cleaned up. | | |
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## Student Competency Sheet

Unit VII: OPERATING LATHES

Module C: Finishing Operations

Task 4: PERFORM SPINNING OPERATION USING FORMING TOOL

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Performance Checklist

1. Set up lathe for spinning.
2. Mount metal work piece.
3. Select and set speeds.
4. Spin to specifications.
    a. Lubricate when necessary
    b. Anneal when necessary
5. Polish or buff (if applicable).

Test

Items Needed:
1. Blueprint
2. Work piece
3. Lathe
4. Lathe accessories
5. Ball bearing center
6. Spinning tool post
7. Chucks
8. Form or mandrel
9. Spinning tools
10. Annealing equipment
11. Measuring instruments
12. Polishing and buffing supplies
13. Follow block

Task:
1. Set up lathe.
2. Spin form metal work piece within an accuracy of 0.005".

Standard: The metal work piece will be formed with 0.005" accuracy.

---

Learning Activities

1. Read one of the following:

    a. Metalwork Technology and Practices (Ludwig/McCarthy), pp. 495-498.
    b. Manufacturer's manual for metal spinning.

2. Observe a demonstration by instructor on metal spinning.

3. In Safety Notebook, write:
    a. Five personal safety practices.
    b. Five general shop safety practices.
4. Research metal spinning lathes:
    a. Write a report.
    b. Give an oral report.
5. List metals that can be spun.
6. Practice metal spinning.
7. Obtain a work order from instructor:
    a. Select safety equipment.
    b. Obtain material needed.
    c. Set up lathe.
    d. Perform spinning operation.
    e. Submit project to instructor for evaluation.
    f. Clean up work area.

INSTRUCTOR CHECK SHEET - METAL SPINNING

| ACTIVITIES | RATING | |
|---|---|---|
| | ACCEPTABLE | NOT ACCEPTABLE |
| 1. Safety equipment utilized. | | |
| 2. Lathe set up correctly. | | |
| 3. Correct speed used. | | |
| 4. Correct tools used. | | |
| 5. Project turned to specifications. | | |
| 6. Cleaned up work area. | | |
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# Student Competency Sheet

## Unit VII: OPERATING LATHES

### Module D: Boring and Drilling Operation

### Task 1: DRILL HOLES WITH LATHE

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## Performance Checklist

1. Chuck work piece in lathe.
2. Select and set speed (repeat in steps 3-4, as necessary).
3. Face and center drill work piece.
4. Lubricate and drill hole to specifications.

## Test

Items Needed:
1. Blueprint
2. Work piece
3. Lathe and accessories
4. Cutting tool
5. Combination drill and countersink
6. Drills
7. Lubricant
8. Precision measurement instruments

Task: Drill hole to blueprint specifications.

Standard: The required accuracy of the drilled hole, within 0.001" for drills of 1/8" to 1" diameters, is:
1. Maximum size - 0.005" + 0.005D
2. Minimum oversize - 0.001" + 0.003D

(Applies where D = nominal drill diameter in inches)

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## Learning Activities

1. Read two of the following:
   a. Machining Fundamentals (Walker), pp. 189-191.
   b. Machinists Library; Basic Machine Shop (Black), p. 178.
   c. Metalwork Technology and Practices (Ludwig/McCarthy), p. 485.
   d. Turning Technology-Engine and Turret Lathes (Krar/Oswald), pp. 188-190.
2. Observe demonstrations by instructor:
   a. Drilling with drill held in head.
   b. Drilling with drill held in tail stock.

3. In Safety Notebook, write:

    a. Three personal safety practices.
    b. Three general shop safety practices.

4. You have to drill a 3/4" diameter hole on the drill press:

    a. What size drill bits would you use?
    b. Discuss your answer.

5. Practice drilling on lathe.

6. Obtain job work order from instructor:

    a. Select safety equipment.
    b. Select material specified.
    c. Set up lathe.
    d. Mount work.
    e. Drill project to specifications.
    f. Clean work area.
    g. Submit project to instructor for evaluation.

INSTRUCTOR CHECK SHEET - DRILLING ON ENGINE LATHE

| | RATING | |
|---|---|---|
| ACTIVITIES | ACCEPTABLE | NOT ACCEPTABLE |
| 1. Safety equipment utilized. | | |
| 2. Selected specified material. | | |
| 3. Set up lathe correctly.<br>Lathe speed correct. | | |
| 4. Correct drills used.<br>a. Set drilling<br>b. Drill ground correctly for material | | |
| 5. Work performed to specifications. (Max. size -0.005" +0.005D, Min. oversize -0.001" +0.003D, applies where D = nominal drill diameter in inches) | | |
| 6. Work area cleaned up. | | |
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# Student Competency Sheet

## Unit VII: OPERATING LATHES

### Module D: Boring and Drilling Operation

### Task 2: BORE HOLES WITH LATHE

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### Performance Checklist

1. Chuck work piece in lathe.
2. Select and set lathe speed (repeat in steps 3-7, as needed).
3. Face and square work piece.
4. Center drill work piece.
5. Step-drill work piece.
6. Rough bore hole.
7. Bore to specifications.

### Test

Items Needed:
1. Blueprint
2. Work piece
3. Lathe and attachments
4. Cutting tool
5. Combination drill and countersink
6. Drills
7. Boring bar
8. Inside calipers
9. Micrometer calipers
10. Steel rule

Task: Using the lathe, bore a hole to blueprint specifications.

Standard:
1. Depth of hole must be ± 1/64" of specifications.
2. Diameter must be ± 0.003" tolerance.

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### Learning Activities

1. Read two of the following:
    a. *Machining Fundamentals* (Walker), pp. 187-190.
    b. *Machinists Library; Basic Machine Shop* (Black), pp.178-180.
    c. *Metalwork Technology and Practices* (Ludwig/McCarthy), pp. 485-486.
    d. *Turning Technology-Engine and Turret Lathes* (Krar/Oswald), pp. 191-193.
2. Read the manufacturer's instruction manual on boring procedures.

3. Observe demonstrations by instructor on boring:
    a. Using drill bits.
    b. Using boring bar.
    c. Using internal calipers and micrometer.

4. In Safety Notebook, write:
    a. Three personal safety practices.
    b. Three general shop safety practices.

5. Practice boring on lathe.

6. Obtain job work order from instructor:
    a. Select safety equipment.
    b. Obtain specified material and tools.
    c. Set up lathe for boring operation.
    d. Perform boring operation.
    e. Submit project to instructor for evaluation.
    f. Clean up work area.

INSTRUCTOR CHECK SHEET -BORING HOLES ON AN ENGINE LATHE

| ACTIVITIES | RATING | |
|---|---|---|
| | ACCEPTABLE | NOT ACCEPTABLE |
| 1. Safety equipment utilized. | | |
| 2. Material according specifications. | | |
| 3. Lathe set up correctly. | | |
| 4. Lathe speed correct. | | |
| 5. Lathe feed correct (if using boring bar). | | |
| 6. Project mounted correctly. | | |
| 7. Project bored to specifications:<br>Depth ± 1/64" - Diameter ± 0.003" | | |
| 8. Area cleaned up. | | |
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# Student Competency Sheet

## Unit VII: OPERATING LATHES

### Module D: Boring and Drilling Operation

### Task 3: COUNTERBORE HOLES WITH LATHE

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## Performance Checklist

Large Diameter

1. Chuck stock in lathe.
2. Mount boring bar.
3. Adjust boring bar and carriage stops.
4. Make roughing cuts.
5. Check roughing dimensions.
6. Adjust micrometer collar on lathe for final finish cut.

Small Diameter

1. Chuck stock in lathe.
2. Mount counterboring tool in tail stock.
3. Lock tail stock to bed.
4. Feed to desired depth with tail stock hand wheel.

## Test

Items Needed:
1. Blueprint
2. Faced stock with drilled hole
3. Boring bar
4. Cutting tool
5. Lathe and attachments
6. Inside precision measurement instruments - micrometer depth gage
7. Counterboring tool set

Task: Counterbore hole to blueprint specifications.

Standard: Hole must be counterbored to specifications. Diameter +0.003 and depth to ± 1/64".

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## Learning Activities

1. Read two of the following:

   a. Machining Fundamentals (Walker), p.115.
   b. Machinists Library; Basic Machine Shop (Black), pp.111-112.
   c. Metalwork Technology and Practices (Ludwig/McCarthy), pp. 485-486.
   d. Manufacturer's manual on **counterboring.**
   e. Turning Technology-Engine and Turret Lathes (Krar/Oswald), pp. 194-196.

2. Attend lecture/demonstration by instructor:
    a. Using counterboring tool on lathe.
    b. Using boring bar technique for counterboring.
3. In Safety Notebook, write:
    a. Three personal safety practices.
    b. Three general shop safety practices.
4. Practice counterboring small diameters on lathe.
5. Practice counterboring large diameters on lathe.
6. Obtain work piece and blueprint from instructor:
    a. Select safety equipment.
    b. Select the best technique to accomplish the counterboring required.
    c. Set up the lathe based on the procedure decided upon.
    d. Counterbore to specs of the blueprint.
    e. Clean up work area.
    f. Submit counterbored project to instructor for evaluation.

INSTRUCTOR CHECK SHEET - COUNTERBORING ON ENGINE LATHE

| ACTIVITIES | RATING | |
|---|---|---|
| | ACCEPTABLE | NOT ACCEPTABLE |
| 1. Safety equipment utilized. | | |
| 2. Work mounted correctly. | | |
| 3. Counterboring technique setup:<br>a. Counterboring tool<br>b. Boring bar | | |
| 4. Speed of lathe correct. | | |
| 5. Automatic feed set correctly. | | |
| 6. Work counterbored to specifications<br>Diameter ± 0.003<br>Depth ± 1/64" | | |
| 7. Work area cleaned. | | |
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## Student Competency Sheet

Unit VII: OPERATING LATHES

Module D: Boring and Drilling Operation

Task 4: COUNTERSINK HOLES USING LATHE

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### Performance Checklist

Using Countersink Cutter

1. Chuck work piece in lathe.
2. Select and set lathe speed (repeat in steps 3-6, as needed).
3. Face and square work piece.
4. Center drill work piece.
5. Drill work piece.
6. Countersink to blueprint specifications.

Using Lathe Cutter Bit

1. Follow steps 1 to 5 under Using Countersink Cutter.
2. Mount cutter on compound rest.
3. Set compound rest angle.
4. Countersink to blueprint specifications.

### Test

Items Needed:
1. Blueprint
2. Work piece
3. Lathe with attachments
4. Combination drill and countersink
5. Drills
6. Lathe cutter bit
7. Countersink cutter

Task:
1. Countersink a hole, using countersink cutter.
2. Countersink a hole, using lathe cutter bit.

Standard: Countersunk holes must be to blueprint specifications.

---

### Learning Activities

1. Read two (2) of the following:
   a. Machining Fundamentals (Walker), p. 114.
   b. Machinists Library; Basic Machine Shop (Black), p. 110.
   c. Metalwork Technology and Practices (Ludwig/McCarthy), p. 485.
   d. Manufacturer's operational manual on countersink.
   e. Turning Technology-Engine and Turret Lathes (Krar/Oswald), pp. 194-196.

2. Observe a demonstration by the instructor on countersinking.

3. In Safety Notebook, write:

   a. Three (3) personal safety practices.
   b. Three (3) general shop safety practices.

4. Research and write a report on countersinking bits.

5. Practice countersinking:

   a. Drill held in head.
   b. Drill held in tail stock.

6. Obtain work order from instructor:

   a. Select safety equipment.
   b. Select material specified.
   c. Set up lathe and mount work piece.
   d. Countersink to specifications.
   e. Clean up area.
   f. Submit finished project to instructor for evaluation.

INSTRUCTOR CHECK SHEET - COUNTERSINKING ON ENGINE LATHE

| ACTIVITIES | RATING | |
|---|---|---|
| | ACCEPTABLE | NOT ACCEPTABLE |
| 1. Safety equipment utilized. | | |
| 2. Selected correct material. | | |
| 3. Lathe set up correctly. | | |
| 4. Lathe speed correct. | | |
| 5. Work piece drilled correctly. | | |
| 6. Countersinking done to specs. | | |
| 7. Work area cleaned. | | |
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## Student Competency Sheet

Unit VII: OPERATING LATHES

Module D: Boring and Drilling Operation

Task 5: REAM HOLES WITH LATHE

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Performance Checklist

1. Chuck work piece in lathe.
2. Select and set lathe speed (repeat in steps 3-6, if necessary).
3. Face and square work piece.
4. Center drill work piece.
5. Drill and/or bore hole.
6. Ream to specifications.

Test

Items Needed:
1. Blueprint
2. Work piece
3. Lathe attachments
4. Cutting tool
5. Combination drill and countersink
6. Drills
7. Boring bar
8. Reamers and holder
9. Inside caliper
10. Plug gauge
11. Micrometer caliper

Task:
1. Using lathe, drill and/or bore hole.
2. Ream hole to a tolerance of + 0.0001" to 0.0005".

Standard: Reamed hole must be accurate to within +0.0001" to 0.0005" of specifications.

---

Learning Activities

1. Read two (2) of the following:

   a. Machining Fundamentals (Walker), p. 191.
   b. Machinists Library; Basic Machine Shop (Black), pp. 178-179.
   c. Metalwork Technology and Practices (Ludwig/McCarthy), p. 485.
   d. Turning Technology-Engine and Turret Lathes (Krar/Oswald), pp. 196-202.

2. Observe instructor demonstration of reaming on engine lathe.

3. In Safety Notebook, write:

    a. Three (3) personal safety practices.
    b. Three (3) general shop safety practices.

4. Research using hand reamers on engine lathe; write up correct procedure.

5. Practice reaming on engine lathe.

6. Obtain work order from instructor:

    a. Select safety equipment.
    b. Select material specified in work order.
    c. Set up lathe.
    d. Mount and machine work piece to specifications.
    e. Set up reamer; ream work piece to specifications.
    f. Clean up work area.
    g. Submit work to instructor for evaluation.

INSTRUCTOR CHECK SHEET - REAMING HOLES ON ENGINE LATHE

| ACTIVITIES | RATING | |
|---|---|---|
| | ACCEPTABLE | NOT ACCEPTABLE |
| 1. Safety equipment utilized. | | |
| 2. Selected materials specified. | | |
| 3. Work mounted correctly. | | |
| 4. Work drilled correctly. | | |
| 5. Lathe set up for reaming. | | |
| 6. Speed set correctly. | | |
| 7. Work area cleaned. | | |
| 8. Work reamed to specification tolerances. | | |
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## Student Competency Sheet

Unit VII: OPERATING LATHES

Module E: Threading

Task 1: DIE CUT THREADS WITH LATHE, HAND THREADING

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### Performance Checklist

Using Die Stock
1. Chuck round stock in lathe.
2. Chamfer end of stock.
3. Select and mount die in diestock.
4. Align die to round stock.
5. Lubricate and hand thread stock to specifications.

Using Releasing-Type Die Holder
1. Chuck round stock in lathe.
2. Chamfer end of stock.
3. Select and mount die in die holder.
4. Align die to round stock.
5. Lubricate and hand-operate to cut threads to specifications.

### Test

Items Needed:
1. Blueprint
2. Round stock
3. Lathe and accessories
4. Dies
5. Diestock
6. Cutting oil
7. Releasing-type die holder
8. Ring thread gauge
9. Nut

Task:
1. Hand thread external threads on round stock with diestock.
2. Hand thread external threads on round stock with releasing-type die holder.

Standard: Threads and fit must meet blueprint specifications, as determined by using thread gauge and nut.

---

### Learning Activities

1. Read the manufacturer's manual on die cutting with lathe (Hand threading).

2. Observe demonstrations by instructor:

   a. Using diestock on lathe.
   b. Using releasing-type die on lathe.

3. In Safety Notebook, write:

   a. Three (3) personal safety practices.
   b. Three (3) general shop safety practices.

4. Research difference between solid dies, split dies, and releasing dies; write a report.

5. Research thread designs; write a report on their characteristics and applications.

6. Practice hand-threading with dies on lathe.

7. Obtain work order from instructor:

   a. Select safety equipment.
   b. Obtain material to be threaded.
   c. Mount work.
   d. Set up die specified.
   e. Cut threads with die.
   f. Check threads.
   g. Clean up work area.
   h. Submit.

## INSTRUCTOR CHECK SHEET - HAND THREADING ON LATHE WITH DIE

| ACTIVITIES | RATING | |
|---|---|---|
| | ACCEPTABLE | NOT ACCEPTABLE |
| 1. Safety equipment utilized. | | |
| 2. Work mounted correctly. | | |
| 3. Die selection to specifications. | | |
| 4. Work prepared correctly:<br>Tool mount | | |
| Speed<br>Chamfer | | |
| 5. Thread cut correctly and clean. | | |
| 6. Threads meet thread gauge test. | | |
| 7. Threads meet nut test. | | |
| 8. Work area cleaned. | | |
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## Student Competency Sheet

## Unit VII: OPERATING LATHES

### Module E: Threading

### Task 2: DIE CUT THREADS WITH LATHE USING DIE HEADS

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**Performance Checklist**

1. Chuck round stock in lathe.
2. Chamfer end of stock.
3. Select and mount die in die head.
4. Align die to round stock.
5. Select and set speed.
6. Lubricate and thread round stock to specifications.

**Test**

Items Needed:
1. Blueprint
2. Round stock
3. Lathe and accessories
4. Dies
5. Die heads
6. Cutting oil
7. Ring thread gauge
8. Nut

Task: Die thread round stock.

Standard: Threads and fit must meet blueprint specifications, as determined by using thread gauge and nut.

---

**Learning Activities**

1. Read both of the following:
   - a. Lathe manufacturer's manual for using die heads.
   - b. Die head manufacturer's manual for using die heads on machine lathe.

2. Observe a demonstration by instructor on using die heads on a lathe.

3. In Safety Notebook, write:
   - a. Five (5) personal safety practices.
   - b. Five (5) general shop safety practices.

4. Practice using die heads on machine lathe.

5. Obtain job work order from instructor:

    a. Select safety equipment.
    b. Select material specified.
    c. Mount work and prep for die heads.
    d. Select speed and feed according to manufacturer's specs.
    e. Cut threads.
    f. Clean up work area.
    g. Submit work to instructor for evaluation.

INSTRUCTOR CHECK SHEET - DIE CUT THREADS WITH LATHE USING DIE HEADS

| ACTIVITIES | RATING | |
|---|---|---|
| | ACCEPTABLE | NOT ACCEPTABLE |
| 1. Safety equipment utilized. | | |
| 2. Correct material selected. | | |
| 3. Work mounted correctly. | | |
| 4. Lathe set-up:<br>Feed | | |
| Speed | | |
| 5. Die head mounted correctly. | | |
| 6. Lubricant utilized. | | |
| 7. Threads cut correctly. | | |
| 8. Work area cleaned up. | | |
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## Student Competency Sheet

Unit VII: OPERATING LATHES

Module E: Threading

Task 3: CUT EXTERNAL THREADS WITH LATHE

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### Performance Checklist

1. Chuck work piece in lathe.
2. Select and set speed (repeat in steps 3-8, as needed).
3. Face and center drill work piece.
4. Secure work piece between centers.
5. Set compound rest to specifications.
6. Mount and align cutter tool bit.
7. Make thread dial selection.
8. Cut threads to specifications.

### Test

Items Needed:

1. Blueprint
2. Work piece
3. Drill chuck and key
4. Combination drill and countersink
5. Centers
6. Cutters
7. Tool holder
8. Single point threading tool
9. Thread center gauge
10. Lubricant
11. Precision measuring instruments - thread micrometer

Task: Cut external threads on work piece to blueprint specifications.

Standard: Threads must be cut to specifications.

---

### Learning Activities

1. Read two (2) of the following:
   - a. Machining Fundamentals (Walker), pp. 179-187.
   - b. Machinist Library; Basic Machine Shop (Black), pp. 191-220.
   - c. Metalwork Technology and Practices (Ludwig/McCarthy), pp. 488-491.
   - d. Turning Technology-Engine and Turret Lathes (Krar/Oswald), pp. 126-143.

2. Observe instructor's demonstration:
    a. Setting up engine lathe for chasing external threads.
    b. Preparing work piece for thread chasing.
    c. Chasing external threads.
    d. Sharpening thread cutter.

3. In Safety Notebook, write:
    a. Five (5) personal safety practices.
    b. Five (5) general shop safety practices.

4. Research and write a report on thread classifications and fits.

5. Practice chasing threads on an engine lathe.

6. Practice sharpening thread cutter.

7. Obtain job work order from instructor:
    a. Select safety equipment.
    b. Obtain material specified.
    c. Set up engine lathe.
    d. Machine work to specifications.
    e. Set up lathe to chase threads.
    f. Chase threads.
    g. Clean up work area.
    h. Submit project to instructor for evaluation.

## INSTRUCTOR CHECK SHEET - CHASING EXTERNAL THREADS ON ENGINE LATHE

| ACTIVITIES | RATING | |
|---|---|---|
| | ACCEPTABLE | NOT ACCEPTABLE |
| 1. Safety equipment utilized. | | |
| 2. Selected material specified. | | |
| 3. Work mounted on lathe. | | |
| 4. Lathe set-up: | | |
| Speeds | | |
| Feeds | | |
| 5. Work piece prepped correctly. | | |
| 6. Lathe set up for threading: | | |
| Speed | | |
| Feed | | |
| Tool Cutter | | |
| Lubrication | | |
| 7. Thread chased correctly. | | |
| 8. Thread meets specifications of work order. | | |
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## Student Competency Sheet

Unit VII: OPERATING LATHES

Module E: Threading

Task 4: CUT INTERNAL THREADS WITH LATHE

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### Performance Checklist

1. Chuck work piece in lathe.
2. Select and set speed (repeat in steps 3-9, as needed).
3. Face and center drill work piece.
4. Step-drill work piece.
5. Bore hole to specifications.
6. Set compound rest to specifications.
7. Mount and square boring bar.
8. Make thread dial selection.
9. Cut threads to specifications.

### Test

Items Needed:

1. Blueprint
2. Internal thread specifications
3. Work piece
4. Drill chuck and key
5. Combination drill and countersink
6. Drills
7. Cutting tool
8. Boring bar with turning tool bit
9. Single point threading tool
10. Thread center gage
11. Precision measurement instruments

Task: Cut internal threads on work piece to blueprint specifications.

Standard: Threads must be cut to specifications.

---

### Learning Activities

1. Read two (2) of the following:
   a. *Machining Fundamentals* (Walker), pp. 179-187.
   b. *Machinists Library; Basic Machine Shop* (Black), pp. 191-220.
   c. *Metalwork Technology and Practices* (Ludwig/McCarthy), pp. 488-491.
   d. Manufacturer's manual for cutting internal threads.
   e. *Turning Technology-Engine and Turret Lathe* (Krar/Oswald), pp. 210-213.

2. Observe instructor demonstrations:

    a. Setting up lathe for chasing threads.
    b. Chasing internal thread.
    c. Sharpening threading tool bit.
    d. Classification of threads.

3. In Safety Notebook, write:

    a. Five (5) personal safety practices.
    b. Five (5) general shop safety practices.

4. Practice chasing internal threads.

5. Obtain job work order from instructor:

    a. Select safety equipment.
    b. Select material specified.
    c. Set up engine lathe.
    d. Machine work piece to specifications.
    e. Set up lathe for threading.
    f. Cut threads.
    g. Clean up work area.
    h. Submit project for evaluation.

## INSTRUCTOR CHECK SHEET - CHASING INTERNAL THREADS ON ENGINE LATHE

| ACTIVITIES | RATING | |
|---|---|---|
| | ACCEPTABLE | NOT ACCEPTABLE |
| 1. Safety equipment utilized. | | |
| 2. Selected material specified. | | |
| 3. Work mounted on lathe. | | |
| 4. Lathe set-up correct. | | |
| 5. Work piece step drilled. | | |
| 6. Hole bored to specifications. | | |
| 7. Boring bar set correctly. | | |
| 8. Lathe speed correct. | | |
| 9. Lathe feed set correct. | | |
| 10. Thread cut correctly. | | |
| 11. Thread cut to specification. | | |
| 12. Work area cleaned. | | |
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## Student Competency Sheet

Unit VII: OPERATING LATHES

Module E: Threading

Task 5: TAP THREADS WITH LATHE - HAND TAP INTERNAL THREADS

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### Performance Checklist

1. Secure and true work piece in chuck.
2. Face and square work piece.
3. Center drill work piece.
4. Chamfer work piece.
5. Drill tap drill hole.
6. Select and secure tap and tap wrench.
7. Align tap to hole.
8. Tap hole to specifications (remove burrs).
9. Measure work piece.

### Test

Items Needed:
1. Blueprint
2. Work piece
3. Lathe and accessories
4. Cutting tool
5. Lubricant
6. Combination drill and countersink
7. Drills
8. Drill chuck
9. Hand taps
10. Tap wrench
11. "go and no-go" gauges

Task: Tap threads to blueprint fit.

Standard: Threads must be tapped to tolerance specifications.

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### Learning Activities

1. Read the following:
   - a. Manufacturer's manual for using hand tap.
   - b. Turning Technology-Engine and Turret Lathe (Krar/Oswald), pp. 202-205.
2. Observe a demonstration by instructor on using hand tap on engine lathe.

3. In Safety Notebook, write:

   a. Three (3) personal safety practices.
   b. Three (3) general shop safety practices.

4. Practice using hand taps on engine lathe.

5. Obtain job work order from instructor:

   a. Select safety equipment.
   b. Obtain material specified.
   c. Set up lathe and mount work.
   d. Machine work piece to specifications.
   e. Drill, ream, and thread to specifications.
   f. Clean up work area.
   g. Submit work piece to instructor for evaluation.

INSTRUCTOR CHECK SHEET - CUT INTERNAL THREADS WITH LATHE

| ACTIVITIES | RATING | |
|---|---|---|
| | ACCEPTABLE | NOT ACCEPTABLE |
| 1. Safety equipment utilized. | | |
| 2. Selected correct material. | | |
| 3. Work mounted on lathe. | | |
| 4. Lathe set-up correct. | | |
| 5. Work piece machined to specifications. | | |
| 6. Threads cut correctly. | | |
| 7. Threads cut to specifications. | | |
| 8. Work area cleaned. | | |
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# Student Competency Sheet

Unit VII: OPERATING LATHES

Module E: Threading

Task 6: RECHASE THREADS ON LATHE

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## Performance Checklist

1. Center or chuck work piece in lathe.
2. Mount and align single point tool.
3. Select and set speed and feed.
4. Cut threads to blueprint specifications.

## Test

Items Needed:
1. Blueprint
2. Threaded work piece
3. Lathe and attachments
4. Single point tool
5. Thread center gauge
6. Lubricant
7. Thread pitch micrometer

Task: Rechase threaded work piece threads to blueprint specifications.

Standard: Threads must be cut to specifications.

---

## Learning Activities

1. Read two (2) of the following:
   - a. Machining Fundamentals (Walker), pp. 179-186.
   - b. Machinists Library; Basic Machine Shop (Black), pp. 191-219.
   - c. Metalwork Technology and Practices (Ludwig/McCarthy), pp. 488-491.
   - d. Manufacturer's manual for rechasing thread operations.
   - e. Turning Technology-Engine and Turret Lathes (Krar/Oswald), pp. 126-143.
2. Observe a demonstration by the instructor:
   - a. Rechasing external threads.
   - b. Rechasing internal threads.
   - c. Using a thread pitch micrometer.

3. In Safety Notebook, write:

    a. Three (3) personal safety practices.
    b. Three (3) general shop safety practices.

4. Practice setting up lathe and rechasing threads.

5. Obtain job work order from instructor:

    a. Select safety equipment.
    b. Mount work piece in lathe.
    c. Determine threads per inch; set up lathe.
    d. Align cutter and thread dial.
    e. Rechase threads.
    f. Clean up work area.
    g. Have instructor evaluate work piece.

INSTRUCTOR CHECK SHEET - RECHASING THREADS

| | RATING | |
|---|---|---|
| ACTIVITIES | ACCEPTABLE | NOT ACCEPTABLE |
| 1. Safety equipment utilized. | | |
| 2. Work mounted correctly. | | |
| 3. Lathe speed correct. | | |
| 4. Lathe feed correct. | | |
| 5. Cutter mounted correctly. | | |
| 6. Tool aligned correctly to existing threads. | | |
| 7. Thread rechased. | | |
| 8. Thread meets original specifications. | | |
| 9. Work area cleaned. | | |
| | | |
| | | |

## Student Competency Sheet

Unit VII: OPERATING LATHES

Module F: Lathe Maintenance

Task 1: PERFORM PREVENTIVE MAINTENANCE ON LATHE

---

### Performance Checklist

1. Inspect lathe for maintenance/minor repairs needed.
2. Clean lathe.
3. Lubricate lathe.
4. Perform other routine preventive maintenance (as needed).
5. Make minor repairs or adjustments (as needed).

### Test

Items Needed:
1. Operation manual or manufacturer's specifications.
2. Cleaner
3. Lubricant
4. Hand tools
5. Precision measurement instruments
6. Lathe

Task: Perform preventive maintenance on lathe, according to operation manual or manufacturer's specifications.

Standard: All activities on the Instructor Check Sheet must be rated by your instructor as satisfactorily performed.

---

### Learning Activities

1. Read one (1) of the following:
   a. Machining Fundamentals ( Walker), pp. 135-208.
   b. Turning Technology-Engine and Turret Lathes (Krar/Oswald), pp. 22-29.
2. Read the manufacturer's maintenance manual.
3. Attend lecture-demonstration by instructor:
   a. Maintenance of engine lathe.
   b. Maintenance of turret lathe.
   c. Cleaning materials.
   d. Lubricating metal lathes.
   e. Perform preventive maintenance on lathe.

INSTRUCTOR CHECK SHEET - MAINTENANCE LATHE

| ACTIVITIES | RATING | |
|---|---|---|
| | ACCEPTABLE | NOT ACCEPTABLE |
| 1. Cleaned ways and bed. | | |
| 2. Cleaned compound rest. | | |
| 3. Inspected belts. | | |
| 4. Inspected gear guards. | | |
| 5. Lubricated machine bearings. | | |
| 6. Lubricated ways and gears. | | |
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# Student Competency Sheet

Unit VII: OPERATING LATHES

Module F: Lathe Maintenance

Task 2: INSPECT LATHE FOR SAFE OPERATION

---

## Performance Checklist

1. Lathe is in proper repair.
2. All guards in place and functional.
3. Work mounted correctly.
4. Tools attached properly.
5. Operation being performed correctly.

## Test

| | |
|---|---|
| Items Needed: | Engine lathe set up for operation; safety charts |
| Task: | Inspect lathe set-up for safety. |
| Standard: | 1. All safety regulations will be in conformance.<br>2. Lathe will be in safe operational condition. |

---

## Learning Activities

1. Read one (1) of the following:
    a. Machining Fundamentals (Walker), pp. 135-209.
    b. Machinists Library; Basic Machine Shop (Black), pp. 127-254.
2. Attend lecture-demonstration by instructor:
    a. Lathe set-up.
    b. Safety regulations.
    c. Operating lathe.
3. In Safety Notebook, write:
    a. Ten (10) personal safety practices.
    b. Ten (10) general safety practices.
4. Study/discuss Information Sheet VII-F-2.
5. Study/discuss inspector's safety charts.
6. Write a safety check list for lathe inspection.

## Information Sheet VII-F-2

## METAL LATHE SAFETY

1. Do not attempt to operate the lathe until you have been checked out on it and are thoroughly familiar with its operation.

2. Remove sweater, wrist watch and rings. Wear properly fitted eye protection and clothing.

3. Check to see that all safety guards are in place.

4. Before turning on the power, check to see that the tailstock, toolholder, and job are properly clamped.

5. Use hand power only when putting on or taking off chuck or faceplate. Do not use the power that operates the lathe to perform this task.

6. Never leave the chuck wrench or any other tool in the chuck. If the machine is turned on, wrench may fly out and injure the operator or other person.

7. Do not use wrench on revolving work or parts. This can prove to be a very dangerous urge or temptation which may result in the loss of eye or result in other bodily injuries.

8. When filing, be sure tang of file is protected by a strong wooden handle. File left-handed so that no portion of your body is over chuck or faceplate as would be the case in right-hand filing. Stand to one side so that, if the file is forced upward, it will go past the body rather than against it.

9. Do not attempt to remove chips with fingers. Remember that the chips are razor sharp.

10. Stop the machine before making any measurements or adjustments.

INSTRUCTOR CHECK SHEET

| ACTIVITIES | RATING | |
|---|---|---|
| | ACCEPTABLE | NOT ACCEPTABLE |
| 1. Checked belt condition. | | |
| 2. Checked that tailstock is secure. | | |
| 3. Checked bed. | | |
| 4. Checked chucking system | | |
| 5. Checked compound rest. | | |
| 6. Checked taper attachment. | | |
| 7. Checked tool support and tool. | | |
| 8. Checked work mounting. | | |
| 9. Checked speeds. | | |
| 10. Checked feet rate. | | |
| 11. Checked that operator is wearing safety equipment. | | |
| 12. Checked that machine is oiled and lubricated. | | |
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INSTRUCTOR CHECK SHEET

| ACTIVITIES | RATING | |
|---|---|---|
| | ACCEPTABLE | NOT ACCEPTABLE |
| 1. Proper shop dress. | | |
| 2. Shop precautions followed. | | |
| 3. Filing procedures. | | |
| 4. Following proper measuring procedures. | | |
| 5. Removing and replacing work-holding devices. | | |
| 6. Proper placement of tools (measuring and lathe) | | |
| 7. Placement of work in the work-holding devices. | | |
| 8. Proper use of the shop air supply. | | |
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## UNIT VIII

## OPERATING SHAPERS

### Terminal Objectives

Upon completion of the modules in this unit, you will be able to:

- Perform preventive maintenance on a shaper
- Inspect a shaper for safe operation
- Align a shaper attachment, work piece, and cutting tool
- Select and set speeds and feeds of shapers
- Select, shape, and sharpen cutting tools for shaper operation
- Machine horizontal, vertical, and angular surfaces on a shaper
- Mill slots and keyways on a shaper

## Student Competency Sheet

Unit VIII: OPERATING SHAPERS

Module A: Setting Up

Task 1: ALIGN SHAPER ATTACHMENT, WORK PIECE, AND CUTTING TOOL

---

### Performance Checklist

1. Secure work-holding device.
2. Mount and align key stock.
3. Square work piece to ram head.
4. Replace key stock with work piece.
5. Adjust shaper and cutter to work piece.
    a. Adjust clapper box.
    b. Adjust for clearance.
    c. Adjust for length of stroke.

### Test

Items Needed:

1. Blueprint
2. Work piece
3. Shaper operations manual
4. Shaper and accessories
5. Work-holding device
6. Aligning key stock
7. Dial indicator
8. Combination set
9. Cutting tool

Task: Align shaper attachment, work piece, and cutting tool.

Standard:

1. Cutting tool heel must be within 4°.
2. Ram stroke must be 1/4" beyond work piece on forward stroke and 1/2" beyond work piece on return stroke.

---

### Learning Activities

1. Read two (2) of the following:
    a. Machining Fundamentals (Walker), pp. 209-215.
    b. Machinists Library; Basic Machine Shop (Black), pp. 311-336.
    c. Metalwork Technology and Practices (Ludwig/McCarthy) pp. 499-513.

2. Attend lecture-demonstrations by instructor:
    a. Shaper nomenclature
    b. Shaper attachments
    c. Alignment of work piece
    d. Adjusting clappers and stroke
    e. Adjusting table

3. Write in Safety Notebook:
    a. Five (5) personal safety practices.
    b. Five (5) general shop safety practices.

4. Practice setting work piece and tool in shaper.

5. Write a set up procedure check list for:
    a. Horizontal cuts.
    b. Vertical cuts.
    c. Combination vertical and horizontal cuts.

6. Obtain job work order from instructor:
    a. Obtain specified material, tools, safety equipment and necessary attachments.
    b. Secure work-holding device.
    c. Secure work piece.
    d. Secure cutter tool.
    e. Align tool and work piece.
    f. Have instructor evaluate set-up.

# Student Competency Sheet

## Unit VIII: OPERATING SHAPERS

### Module A: Setting Up

### Task 2: SELECT AND SET SPEEDS AND FEEDS OF SHAPERS

---

## Performance Checklist

### Select and Set Machine Speed

1. Identify and classify material of work piece.
2. Determine by formula or table desired cutting speed.
3. Approximate by formula the machine speed in cutting strokes per minute.
4. Set driving gear or bull wheel to proper machine speed.

### Select and Set for Cutting Speed

1. Identify and classify material of work piece.
2. Identify cutter material to be used.
3. Determine cutting speed using table specifications.
4. Determine setting of cutting speed based on desired length of cut and shaper strokes per minute.
5. Set up shaper for desired cutting speed following operations manual.

### Select and Set Feed

1. Identify and classify material of work piece.
2. Identify cutter material
3. Determine cutting speed.
4. Determine depth of cut needed.
5. Determine feed according to desired finish.
6. Set feed according to operations manual.

## Test

Items Needed:

1. Blueprint
2. Work piece
3. Machinist's handbook
4. Reference materials
5. Shaper operations manual
6. Shaper hand tools.

Task: Use blueprint and work piece specifications to:

1. Select and set shaper machine speed.
2. Select and set machine for cutting speed.
3. Select and set feed.

Standard:

1. All steps of the Performance Checklist must be performed.
2. Your instructor must inspect and approve calculations.
3. Your inspector must inspect and approve each stage of the set-up.

## Learning Activities

1. Read two (2) of the following:

   a. Machining Fundamentals (Walker), pp. 220-221.
   b. Machinists Library; Basic Machine Shop (Black), pp. 333-335.
   c. Metalwork Technology and Practices (Ludwig/McCarthy) pp. 505-507.

2. Attend lecture-demonstration by instructor:

   a. Selecting and setting speed.
   b. Selecting and setting feed rate.
   c. Setting speed and feed on shaper.

3. Write in Safety Notebook five (5) reasons why speed and feed rate must be set correctly.

4. List five (5) considerations to be considered before calculating speed and feed rate.

5. Write an explanation for the two (2) formulas below:

$$N = \frac{CS \times 7}{L} \quad \text{and} \quad N = \frac{CS}{0.14 \times L}$$

6. Practice calculating speed and feed rate.

7. Obtain job work order from instructor:

   a. Select safety equipment, tool and materials required.
   b. Mount work and cutter tool.
   c. Align work piece and cutter
   d. Set ram stroke.
   e. Calculate speed and set accordingly.
   f. Calculate feed rate and set accordingly.
   g. Have instructor evaluate set-up.
   h. Clean up work area.

## Student Competency Sheet

Unit VIII: OPERATING SHAPERS

Module A: Setting Up

Task 3: SELECT, SHAPE, AND SHARPEN CUTTING TOOLS FOR SHAPER OPERATION

---

### Performance Checklist

Cutter Selection

1. Identify work piece material.
2. Determine type of cut (roughing/finishing).
3. Determine profile of cutter to perform machining operation.
4. Select proper cutter.

Shape and Sharpen

1. Repeat steps 1 to 3 under cutter selection.
2. Select cutter for job and to fit tool holder.
3. Check and dress grinding wheel.
4. Grind tool to rough desired shape (use coolants as necessary).
5. Measure to determine finish cuts.
6. Grind tool to desired specifications and sharpen.

### Test

Items Needed:

1. Blueprint
2. Work piece
3. Reference book
4. Combination square
5. Radius gauge
6. Cutting tool or blanks
7. Bench grinder
8. Coarse and fine grinding wheels
9. Coolant
10. Wheel dresser

Task:

1. Select proper cutting tool to perform shaper operation according to blueprint specifications.
2. Shape and sharpen cutting tool.

Standard:

1. The radius of the cutting tool must be ± 1/32" of table specifications.
2. The angular measurement of the cutting tool must be ± 1/2° of table specifications.

Learning Activities

1. Read two (2) of the following:

    a. Machining Fundamentals (Walker), pp. 221-222.
    b. Machinists Library; Basic Machine Shop (Black), pp. 315-316.
    c. Metalwork Technology and Practices (Ludwig/McCarthy), pp. 509-512.

2. Attend lecture-demonstration by instructor:

    a. Tool cutter selections.
    b. Sharpening cutter tool.

3. Sketch five (5) commonly used cutters and label the angles.

4. Practice sharpening cutters.

5. Sharpen the following cutters and have the instructor evaluate:

    a. Left hand side roughing tool
    b. Left hand side finishing tool
    c. Finishing tool
    d. Left hand roughing tool
    e. Parting or slotting tool

## Student Competency Sheet

Unit VIII: OPERATING SHAPERS

Module B: Cutting Operation

Task 1: SURFACING

---

Performance Checklist

1. Identify and classify material of work piece.
2. Secure work piece to table.
3. Select and secure cutter.
4. Select and adjust stroke length.
5. Align cutter to work piece.
6. Set speed and feed for rough cut.
7. Perform rough cut.
8. Set speed and feed finish cut.
9. Perform finish cut.

Test

Items Needed:
1. Blueprint
2. Work piece
3. Work-holding device
4. Cutter tool
5. Shaper and attachments

Task:
1. Machine a horizontal surface on a shaper.
2. Machine a vertical surface on a shaper.
3. Machine an angular surface.

Standard: Surface must be machined to blueprint specifications.

---

Learning Activities

1. Read two (2) of the following:
   - a. Machining Fundamentals (Walker), pp. 210-221.
   - b. Machinists Library; Basic Machine Shop, (Black), pp. 311-336.
   - c. Metalwork Technology and Practices (Ludwig/McCarthy), pp. 499-519.
2. Attend a lecture-demonstration by instructor:
   - a. Machining horizontal surfaces.
   - b. Machining vertical surfaces.
   - c. Machining angular surfaces.

3. In Safety Notebook, write:
    a. Five (5) personal safety practices.
    b. Five (5) general shop safety practices.

4. Practice machining with shaper on horizontal, vertical, and angular surfaces.

5. Obtain job work order from instructor:
    a. Select material, tools, and cutter bit.
    b. Set up shaper and work piece.
    c. Have instructor evaluate set-up.
    d. Rough cut to specifications.
    e. Re-tool for finished cut.
    f. Finish cut to specifications.
    g. Submit finished work piece to instructor for evaluation.
    h. Clean up work area.

# Student Competency Sheet

## Unit VIII: OPERATING SHAPERS

### Module B: Cutting Operation

### Task 2: MACHINE SLOTS AND KEYWAYS

---

## Performance Checklist

1. Identify and classify material of work piece.
2. Secure work piece to table.
3. Select and secure cutter.
4. Select and adjust stroke length.
5. Align cutter to work piece.
6. Set speed.
7. Slot to specifications.

## Test

Items Needed:
1. Blueprint
2. Work piece
3. Work-holding device
4. Shaper and attachments
5. Slotting cutter tool
6. Precision measurement instruments

Task: Machine slot and keyways to blueprint specifications.

Standard: Slot must be machined to a tolerance of $\frac{+0.010''}{-0.000''}$ of blueprint specifications.

---

## Learning Activities

1. Read two (2) of the following:
   - a. Machining Fundamentals (Walker), pp. 219-226.
   - b. Machinists Library; Basic Machine Shop (Black), pp. 355-366.
   - c. Metalwork Technology and Practices (Ludwig/McCarthy), pp. 520-521.

2. Attend a lecture-demonstration by instructor:
   - a. Cutting external keyway.
   - b. Cutting internal keyway.
   - c. Cutting blend keyways.

3. In Safety Notebook, write:

    a. Five (5) personal safety practices.
    b. Five (5) general shop safety practices.

4. Practice cutting internal keyways and external keyways.

5. Obtain job work order from instructor:

    a. Obtain material and safety equipment.
    b. Set up shaper.
    c. Have instructor evaluate set-up.
    d. Machine keyway to specifications.
    e. Clean up work area.

# Student Competency Sheet

## Unit VIII: OPERATING SHAPERS

### Module C: Maintenance

### Task 1: PERFORMING PREVENTIVE MAINTENANCE

---

### Performance Checklist

1. Inspect table adjustment.
2. Inspect clapper box.
3. Inspect ram adjustment.
4. Inspect vise.
5. Inspect feed controls.
6. Repair or replace defective parts.
7. Lubricate machine.

### Test

Items Needed:
1. Operation manual
2. Shaper and attachments
3. Assorted tools
4. Lubricants

Task: Perform preventive maintenance

Standard:
1. Defective parts must be identified and repaired or replaced.
2. Parts must be aligned, adjusted, and lubricated according to manufacturer's instructions.
3. Shaper must be in safe operating condition.

---

### Learning Activities

1. Read the manufacturer's instructional manual for proper alignment and adjustment techniques.

2. Attend lecture-demonstration by instructor:

   a. Operating shaper.
   b. Preventive shaper maintenance.

3. In Safety Notebook, write:

   a. Five (5) safety check points.
   b. Five (5) personal safety practices.

4. With a partner, write a checklist for maintenance of shaper.

5. As a class, write a checklist for maintenance of a shaper.

6. Use the class checklist:

    a. Inspect a shaper; identify repairs/replacements.
    b. Have your instructor check your findings.
    c. Repair/replace parts.
    d. Lubricate the shaper.
    e. Check operation.
    f. Have your instructor evaluate your work.

# Student Competency Sheet

## Unit VIII: OPERATING SHAPERS

### Module C: Maintenance

### Task 2: INSPECT FOR SAFE OPERATION

---

Performance Checklist

1. Check to be sure shaper is in proper repair.
2. Check to be sure cutter is properly secured and aligned.
3. Check to be sure work piece is secured and aligned correctly.
4. Check ram travel.
5. Check speed and feed.
6. Check to be sure safety equipment is utilized.

Test

Items Needed:
1. Shaper and attachments
2. Cutter tool
3. Work piece
4. Safety equipment

Task: Inspect shaper for safe operation.

Standard:
1. All parts must be in safe operating condition.
2. All operations must comply with safety regulations.

---

Learning Activities

1. Read two (2) of the following:
    a. Machining Fundamentals (Walker), pp. 209-228.
    b. Machinists Library; Basic Machine Shop (Black), pp. 311-336.
    c. Metalwork Technology and Practices (Ludwig/McCarthy), pp. 499-523.
2. Attend lecture-demonstration by instructor:
    a. Operation of metal shapers.
    b. Preventive maintenance.
    c. Safety inspection of shaper.
3. In Safety Notebook, write:
    a. Ten (10) general safety practices for shapers.
    b. Five (5) personal safety practices.

4. Write a safety checklist for the shaper.

5. Inspect a shaper operation for safety:

    a. Note all violations of safety practices.
    b. Write procedures to correct safety violations.
    c. Have your instructor evaluate your work.

# UNIT IX

## OPERATING GRINDING MACHINES

### Terminal Objectives

Upon completion of the modules in this unit, you will be able to:

- Inspect a grinder for safe operation
- Inspect grinding wheels
- Perform preventive maintenance on a grinder
- Store grinding wheels
- Balance grinding wheels
- Dress and true grinding wheels
- Attach and align materials for grinding operations
- Set up a grinder to run a work piece between centers
- Set up a surface grinder to run on magnetic chuck
- Select and set speeds and feeds of power feed grinders
- Perform grinding operations, as per set-up
- Cut off or part material with grinding machines
- Polish with a grinding machine
- Measure, inspect, and rework work pieces on grinding machines
- Set up and perform surface grinding operations
- Set up, grind, and sharpen preshaped lathe tools, using a tool grinder
- Set up a universal grinder and sharpen plain milling cutters
- Set up a tool grinder and shape cold chisels
- Set up an abrasive belt grinder
- Use an abrasive belt grinder

## Student Competency Sheet

Unit IX: OPERATING GRINDING MACHINES

Module A: Setting Up For Grinding

Task 1: INSPECT GRINDING WHEELS

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### Performance Checklist

1. Lift wheel carefully.
2. Inspect visually for cracks, chips, or other defects.
3. Hold or suspend wheel and ring test for cracks.
4. If wheel is mounted:
    a. Ring test for cracks
    b. Adjust and secure all guards
    c. If the wheel "ring tests" to indicate no cracks, insure no one is near by, stand to one side, and run the wheel at full speed for at least one minute to insure check.

### Test

Items Needed:
1. Grinding wheel
2. Non-metallic implements

Task:
1. Inspect grinding wheel for visible damage
2. Ring test grinding wheel for cracks
3. Report damage to your instructor

Standard: Your instructor must rate your inspection findings as satisfactory.

---

### Learning Activities

1. Read:
    a. Grinding Technology (Krar/Oswald), pp. 7-67.
    b. Machining Fundamentals (Walker), pp. 287-295.
    c. Metalwork Technology and Practices (Ludwig/McCarthy), pp. 397-402.

2. Attend a lecture-demonstration by instructor on:
    a. Types of grinders.
    b. Types and shapes of grinding wheels.
    c. Inspecting grinding wheels.
    d. Handling grinding wheels.

3. In Safety Notebook, write:

   a. Ten (10) personal safety practices.
   b. Ten (10) general shop safety practices.

4. Research grinding wheel enumeration and interpret the meaning of 32A46-H8VBE and 51A36-L5V23. Discuss with class.

5. Inspect a selection of grinding wheels supplied by your instructor. Determine if they are safe for use. Your determination must agree with the instructor's.

6. Research and write a report on the types of grinders and their applications.

## INSTRUCTOR CHECK SHEET - Inspecting Grinding Wheels

A. Inspect at least four (4) grinding wheels provided by your instructor and marked #1, #2, #3, #4, etc. Inspect them for cracks, chips, and ring test. Mark your rating of each as either "S" (if they are safe) or "D" (if they should be discarded because they are unsafe).

| | Inspection/Test | | | RATING | |
|---|---|---|---|---|---|
| Grinding Wheel # | Cracks | Chips | Ring Test | ACCEPTABLE | NOT ACCEPTABLE |
| #1 | | | | | |
| #2 | | | | | |
| #3 | | | | | |
| #4 | | | | | |
| #5 | | | | | |
| #6 | | | | | |

B. Research and interpret at least four (4) grinding wheel enumerations supplied by your instructor.

| | Standard Marking Factors | | | | | | RATING | |
|---|---|---|---|---|---|---|---|---|
| Grinding Wheel # | Abrasive | Grit | Grade | Structure | Bond | Norton Symbol | ACCEPTABLE | NOT ACCEPTABLE |
| Example: 32A46-H8VBE | Alundum | Med. | Soft | Wide grain | Vitrified | BE | -- | -- |
| #1 | | | | | | | | |
| #2 | | | | | | | | |
| #3 | | | | | | | | |
| #4 | | | | | | | | |
| #5 | | | | | | | | |

## Student Competency Sheet

Unit IX: OPERATING GRINDING MACHINES

Module A: Setting Up For Grinding

Task 2: BALANCE GRINDING WHEEL

---

### Performance Checklist

1. Mount hub or wheel mount on arbor.
2. Ring test wheel for cracks (replace if cracked).
3. Mount on balance stand.
4. Adjust weights to balance hub.
5. Remount hub or wheel mount on grinder.
6. Mount wheel to hub, following manufacturer's specifications.

### Test

Items Needed:

1. Grinding wheel
2. Wheel mount
3. Balance stand
4. Weights
5. Wheel manufacturer's specifications

Task: Balance the grinding wheel.

Standard:

1. The wheel must be balanced according to the specifications.
2. Your instructor must rate each step of the Performance Checklist as being satisfactorily performed.

---

### Learning Activities

1. Read two (2) of the following:
    a. Grinding Technology (Krar/Oswald), pp. 68-76.
    b. Machining Fundamentals (Walker), pp. 294 and 296-298.
    c. Metalwork Technology and Practices (Ludwig/McCarthy), pp. 574-576.
    d. Grinder manufacturer's manual for balancing wheels.
2. Observe demonstration by instructor:
    a. Static balancing
    b. Dynamic (automatic) balancing

3. In Safety Notebook, write:
    a. Five (5) personal safety practices.
    b. Five (5) general safety practices.

4. Research and write a procedure for:
    a. Static balancing.
    b. Dynamic balancing.

5. Practice balancing grinding wheels.

6. From your instructor obtain grinding wheel that needs to be balanced:
    a. Select safety equipment.
    b. Balance wheel.
    c. Submit wheel to instructor for evaluation.

## Student Competency Sheet

Unit IX: OPERATING GRINDING MACHINES

Module A: Setting Up For Grinding

Task 3: DRESS AND TRUE GRINDING WHEELS

---

### Performance Checklist

1. Ring test wheel for cracks (replace if cracked).
2. Select diamond point dresser.
3. Place truing tool in tool post or attachment.
4. Set speed of grinder at regular grinding rate.
5. Insure guards and safety equipment are appropriate.
6. Adjust for depth or cut.
7. Apply coolants/lubricants, if applicable.
8. Dress and true wheel to reference specifications.

### Test

Items Needed:
1. Reference book
2. Grinder
3. Grinding wheel
4. Diamond point dresser
5. Fixed tool post

Task: Dress and true the wheel to reference specifications.

Standard: Wheel must be dressed and trued to specifications.

---

### Learning Activities

1. Read two (2) of the following:
    a. Grinding Technology (Krar/Oswald), pp. 77-84.
    b. Machining Fundamentals (Walker), pp. 291-298.
    c. Metalwork Technology and Practices (Ludwig/McCarthy), pp. 574-576.
    d. Grinder's manufacturer's manual.
2. Attend lecture-demonstrations by instructor:
    a. Testing grinding wheels for safety.
    b. Dressing tools for grinders.
    c. Dressing grinding wheels.
    d. Grinder safety.

3. In Safety Notebook, write:
    a. Five (5) personal safety practices.
    b. Ten (10) general safety practices for the grinder.

4. Practice dressing grinding wheels.

5. Write a procedure for dressing each of the following:
    a. Mechanical dresser
    b. Surface grinder wheel
    c. Cylindrical grinder wheel

6. Review your written procedure (Learning Activity #5) with a partner and with instructor.

7. Perform dressing and truing operation for instructor's evaluation.

2. Attend demonstrations by instructor:
   - a. Attaching and aligning surface grinder work.
   - b. Attaching and aligning cylindrical grinder work.

3. In Safety Notebook, write:
   - a. Five (5) personal safety practices.
   - b. Ten (10) safety practices for surface grinders.
   - c. Ten (10) safety practices for cylindrical grinders.

4. Write a procedure checklist for attaching and aligning material:
   - a. Surface grinder
   - b. Cylindrical grinder

5. Practice setting up grinder.

6. Obtain work order from instructor and work piece:
   - a. Select safety equipment.
   - b. Mount and align work piece.
   - c. Have instructor evaluate mounting and alignment.

## Student Competency Sheet

Unit IX: OPERATING GRINDING MACHINES

Module A: Setting Up For Grinding

Task 5: SET UP GRINDER TO RUN WORK PIECE BETWEEN CENTERS

---

### Performance Checklist

1. Clean table ways.
2. Secure drive plate, with dead center, on spindle nose.
3. Secure dead center in footstock.
4. Align centers (if necessary).
5. Select and mount grinding wheel:
   a. Check for cracks
   b. Dress and true grinding wheel
6. Secure lathe dog to work piece and mount between centers.
7. Mount, align, and secure steady rest (if needed).
8. Fill machine storage tank with proper coolant.
9. Select and set wheel speed, traverse speed, and depth of cut.

### Test

Items Needed:
1. Cylindrical grinder and accessories
2. Cleaning rags
3. Drive plate
4. Two (2) dead centers
5. Test bar
6. Dial indicator
7. Grinding wheels
8. Diamond point dresser
9. Center drilled work piece
10. Lathe dog
11. Steady rest
12. Coolant
13. Machinist's handbook

Task: Set up grinder to run work piece between centers.

Standard: Your instructor must rate your performance as satisfactory on all steps of the Performance Checklist.

---

### Learning Activities

1. Read two (2) of the following:

   a. Grinding Technology (Krar/Oswald), pp. 140-168.
   b. Machining Fundamentals (Walker), pp. 304-307.
   c. Metalwork Technology and Practices (Ludwig/McCarthy), pp. 567-568.
   d. Cylindrical grinder manufacturer's manual.

2. Observe demonstration by instructor:
    a. Cylindrical grinders
    b. Mounting and alignment of work in cylindrical grinders
    c. Grinding operation

3. In Safety Notebook, write:
    a. Five (5) personal safety practices.
    b. Ten (10) general safety practices.

4. Practice mounting and grinding on cylindrical grinder.

5. Obtain a job work order from instructor:
    a. Select safety equipment.
    b. Select material specified.
    c. Mount work piece.
    d. Grind to specifications.
    e. Clean up work area.
    f. Submit work piece to instructor for evaluation.

6. Compare this technique with grinding on an engine lathe. Discuss with a small group of classmates; point out differences.

## INSTRUCTOR CHECK SHEET - CYLINDRICAL GRINDER - WORK PIECE BETWEEN CENTERS

| ACTIVITIES | RATING | |
|---|---|---|
| | ACCEPTABLE | NOT ACCEPTABLE |
| 1. Safety equipment utilized. | | |
| 2. Drive plate secured to spindle nose. | | |
| 3. Dead center secured. | | |
| 4. Centers aligned. | | |
| 5. Grinding wheels: | | |
| Mounted correctly | | |
| Checked for cracks | | |
| Dressed and trued | | |
| 6. Work piece: | | |
| Mounted correctly | | |
| Aligned | | |
| 7. Grinder: | | |
| Coolant | | |
| Speed | | |
| Feed rate | | |
| Depth of cut | | |
| 8. Work ground to specifications. | | |
| 9. Work area cleaned. | | |
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## Student Competency Sheet

Unit IX: OPERATING GRINDING MACHINES

Module A: Setting Up For Grinding

Task 6: SET UP GRINDER TO RUN ON MAGNETIC CHUCK - SURFACE GRINDER

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Performance Checklist

1. Clean all rust preventative from chuck.
2. Hone to remove all burrs.
3. Place chuck on grinder table pad.
4. Clean and check wheel adapter for burrs (making necessary corrections).
5. Select and mount grinding wheel:
    a. Check wheel for cracks.
    b. Dress and true grinding wheel.
6. Block ends of chuck.
7. Mount work piece to magnetic chuck, using magna-vise clamps and parallel or V-block on irregular shaped or non-magnetic pieces.
8. Engage magnetic holding.
9. Fill machine storage tank with proper coolant.
10. Select and set table traverse speed, cross-feed speed, and infeed or depth of cut.
11. Select and set wheel speed.
12. Secure squeegee, rags, and grease to clean machine after grinding operation.

Test

Items Needed:
1. Grinder
2. Machinery handbook
3. Magnetic chuck
4. Work piece
5. Cleaner
6. Hones
7. Grinding wheel
8. Diamond point dresser
9. Blocks
10. Parallels
11. V-blocks
12. Magna-vise clamps
13. Coolants
14. Squeegee
15. Rags
16. Grease

Task: Set up grinder to run on magnetic chuck.

Standard: All steps on the Performance Checklist must be rated satisfactory by your instructor.

---

Learning Activities

1. Read both of the following:
   a. *Grinding Technology* (Krar/Oswald), pp. 101-132.
   b. Surface grinder manufacturer's manual on operation.
2. Observe demonstrations by instructor:
   a. Preparing work for magnetic chuck.
   b. Setting up surface grinder with magnetic chuck.
   c. Grinding with magnetic chuck.
3. In Safety Notebook, write:
   a. Five (5) personal safety practices.
   b. Ten (10) general safety practices.
4. Practice using surface grinder.
5. Obtain job work order from instructor:
   a. Select safety equipment.
   b. Select material specified and prep for grinding.
   c. Set up grinder.
   d. Mount work.
   e. Grind to specifications.
   f. Clean up work area.
   g. Submit work to instructor for evaluation.

INSTRUCTOR CHECK SHEET - MAGNET CHUCK - SURFACE GRINDER

| | RATING | |
|---|---|---|
| ACTIVITIES | ACCEPTABLE | NOT ACCEPTABLE |
| 1. Safety equipment utilized. | | |
| 2. Clean chuck. | | |
| 3. Chuck mounting. | | |
| 4. Wheels of grinder: | | |
| Mounted correctly | | |
| Checked for damage | | |
| Dressed and trued | | |
| 5. Work piece to chuck: | | |
| Mounting clamps | | |
| Magnet holds | | |
| 6. Grinder: | | |
| Coolant | | |
| Table traverse speed | | |
| Cross-feed speed | | |
| Wheel speed | | |
| 7. Work ground to specifications. | | |
| 8. Work area cleaned. | | |
| 9. Equipment stored correctly. | | |
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## Student Competency Sheet

Unit IX: OPERATING GRINDING MACHINES

Module A: Setting Up For Grinding

Task 7: SELECT AND SET SPEEDS AND FEEDS OF POWER FEED GRINDERS

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### Performance Checklist

1. Identify work piece material.
2. Identify grinding requirements:
    a. Amount of metal to be removed
    b. Desired finish and accuracy
    c. Grinder power and rigidity
3. Compute and determine desired peripheral speed.
4. Determine and set grinder speed.
5. Determine and set grinder feed.

### Test

Items Needed:
1. Blueprint
2. Work piece
3. Grinder operation manual
4. Machinist's handbook

Task: Select and set up speed and feed of power feed grinders to perform grinding operation, according to blueprint specifications, operation manual and table.

Standard: Speeds and feeds of power feed grinders must be selected and set correctly, according to required specifications.

---

### Learning Activities

1. Read both of the following:

    a. Grinding Technology (Krar/Oswald), pp. 148-149.
    b. Grinder manufacturer's operation manual.

2. Attend lecture-demonstration by instructor:

    a. Identifying materials
    b. Finishes
    c. Grinder's capabilities
    d. Calculating peripheral speed
    e. Calculating grinder speed
    f. Calculating grinder feed

3. Write formula used and location of charts for calculating grinder feeds and speeds.

4. Calculate speeds and feed rate for operations specified by instructor. Have instructor check your work.

## Student Competency Sheet

### Unit IX: OPERATING GRINDING MACHINES

### Module B: Grinding Operations

### Task 1: PERFORM GRINDING MACHINE OPERATIONS AS PER SET-UP

---

**Performance Checklist**

1. Determine grinding operation.
2. Select grinder.
3. Select and mount grinding wheel (check for cracks; replace, if necessary).
4. True and dress grinding wheel.
5. Select work-holding device and accessories.
6. Align grinding wheel to work piece.
7. Select coolant.
8. Set speed and feed, if applicable.
9. Grind to specifications.

**Test**

Items Needed:
1. Blueprint
2. Grinders and accessories
3. Work piece
4. Machinist's handbook
5. Grinder operation manuals

Task: Perform grinding machine operations, according to the necessary set-up for the blueprint specifications.

Standard: Grinding must be to an accuracy of 0.0001" to 0.0005".

---

**Learning Activities**

1. Select project requiring grinder operation:
   a. Write out a procedure to be followed to complete project - Include safety requirements.
   b. Perform operation according to written procedure.

2. Obtain job work order from instructor:
   a. Set up and perform grinding machine operation.
   b. Have instructor evaluate your performance.
   c. Have a partner evaluate your work.
   d. Discuss any changes that you feel should be made in the procedure you wrote and followed.
   e. Revise your written procedure, if necessary.
   f. Select another project and repeat steps "b" through "e".

INSTRUCTOR CHECK SHEET - PERFORM GRINDING MACHINE OPERATION

| ACTIVITIES | RATING | |
|---|---|---|
| | ACCEPTABLE | NOT ACCEPTABLE |
| 1. Safety equipment utilized. | | |
| 2. Obtained material specified. | | |
| 3. Selected correct grinder for job. | | |
| 4. Work mounted correctly. | | |
| 5. Grinder speeds and feeds set. | | |
| 6. Wheels inspected for safety. | | |
| 7. Work aligned correctly. | | |
| 8. Work ground to specifications. | | |
| 9. Work area cleaned. | | |
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## Student Competency Sheet

Unit IX: OPERATING GRINDING MACHINES

Module B: Grinding Operations

Task 2: CUT OFF OR PART MATERIALS WITH GRINDING MACHINES

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### Performance Checklist

1. Mount and secure reinforced abrasive cut off wheel.
2. Check wheel and wheel guards (replace defective wheel).
3. Secure work piece in work-holding device.
4. Cut work piece to specifications.

### Test

Items Needed:
1. Blueprint specifications
2. Grinder with attachments
3. Reinforced abrasive cut off wheel
4. Work piece

Task: Part work piece with grinding machined to blueprint specifications.

Standard: Material must be parted to blueprint specifications.

---

### Learning Activities

1. Read the following:
   a. Grinding Technology (Krar/Oswald), pp. 122-127.
   b. Grinder manufacturer's instruction manual.
2. Observe demonstrations by instructor:
   a. Setting up grinder and work piece for cut-off.
   b. Cutting off or parting material with grinder.
3. In Safety Notebook, write:
   a. Five (5) personal safety practices.
   b. Five (5) general safety practices.
4. Write a procedure checklist for doing cut-off work on a grinder.
5. Practice doing cut-off operation on grinder.

6. Obtain job work order from instructor:

   a. Select safety equipment.
   b. Select material specified.
   c. Select reinforced abrasive cut-off wheel.
   d. Set up grinder.
   e. Mount work piece.
   f. Perform cut-off operation.
   g. Clean up work area.
   h. Submit work piece to instructor for evaluation.

## Student Competency Sheet

Unit IX: OPERATING GRINDING MACHINES

Module B: Grinding Operations

Task 3: POLISH WITH GRINDING MACHINE

---

### Performance Checklist

1. Determine work piece material.
2. Select and mount polishing wheel.
3. Select and set speed (if applicable).
4. Secure work piece.
5. Polish to job specifications, applying polishing compounds as needed.

### Test

Items Needed:
1. Job specifications
2. Work piece
3. Grinder
4. Grinder accessories
5. Polishing wheel
6. Polishing compounds

Task: Polish work piece with grinding machine.

Standard: Work piece must be polished to job specifications.

---

### Learning Activities

1. Read one of the following:
    a. Grinding Technology (Krar/Oswald), pp. 89-94.
    b. Grinder manufacturer's operation manual.
2. Observe a demonstration by instructor on polishing with grinder.
3. In safety notebook, write:
    a. Five personal safety practices.
    b. Five general shop safety practices.
4. Practice polishing on grinder.
5. Research polishing compounds and wheels; write a report on both.

6. Obtain a job work order from instructor:

    a. Select safety equipment.
    b. Select material specified.
    c. Set up grinder.
    d. Mount work piece.
    e. Polish to specifications.
    f. Clean up work area.
    g. Submit work piece to instructor for evaluation.

# Student Competency Sheet

## Unit IX: OPERATING GRINDING MACHINES

### Module B: Grinding Operations

### Task 4: MEASURE, INSPECT, AND REWORK WORK PIECE ON GRINDING MACHINES

---

## Performance Checklist

1. Inspect work piece for flaws.
2. Determine rework dimensions.
3. Rework to finish dimensions.

## Test

Items Needed:
1. Blueprint
2. Heat-treated work piece
3. Grinder and accessories
4. Precision measurement instruments

Task:
1. Inspect the work piece
2. Measure the work piece
3. Rework the work piece on the grinding machine to a finish accuracy of +0.0001".

Standard: The reworked work piece must be finished to an accuracy of +0.0001".

---

## Learning Activities

1. Observe demonstration by instructor for reworking work pieces on grinder.

2. Select work piece to be reworked:

   a. Write a procedure to be followed.
   b. Perform operation according to written procedure.
   c. Have a partner evaluate your work.
   d. Discuss any changes that you feel should be made in the procedure you wrote and followed.
   e. Revise your written procedure, if necessary.
   f. Select another work piece and repeat steps "b" through "e".

3. Obtain job work order and piece to be reworked from instructor:

   a. Select safety equipment.
   b. Select grinder that will do rework required.
   c. Set up grinder and work piece.
   d. Perform grinding operation.
   e. Clean up work area.
   f. Submit reworked piece to instructor for evaluation.

# Student Competency Sheet

## Unit IX: OPERATING GRINDING MACHINES

### Module B: Grinding Operations

### Task 5: SET UP AND PERFORM SURFACE GRINDING OPERATIONS

---

Performance Checklist

1. Select and secure work-holding device.
2. Select, check (replace, if necessary), and mount grinding wheel.
3. True and dress wheel.
4. Select and set up speed and feed.
5. Select coolant.
6. Secure and align work piece.
7. Grind to specifications.

Test

Items Needed:
1. Blueprint
2. Operation manual
3. Grinder
4. Grinder accessories
5. Precision measurement instruments
6. Work piece

Task:
1. Set up to manual specifications.
2. Surface grind work piece to an accuracy of 0.0001".

Standard: Surface grinding operation must be performed to an accuracy of 0.0001".

---

Learning Activities

1. Read one of the following:

   a. Grinding Technology (Krar/Oswald), pp. 94-139).
   b. Surface grinder manufacturer's operation manual.

2. Observe demonstrations by instructor:

   a. Dressing and truing grinding wheels.
   b. Mounting and aligning work on surface grinder.
   c. Selecting coolants
   d. Surface grinder operations.

3. In safety notebook, write:

   a. Five personal safety practices.
   b. Five general shop safety practices.

4. Obtain job work order from instructor:

   a. Select safety equipment.
   b. Select material specified.
   c. Set up grinder.
   d. Mount work piece.
   e. Set feed and speeds.
   f. Grind work to specs.
   g. Clean work area.
   h. Submit work piece to instructor for evaluation.

## INSTRUCTOR CHECK SHEET - SURFACE GRINDER

| ACTIVITIES | RATING | |
|---|---|---|
| | ACCEPTABLE | NOT ACCEPTABLE |
| 1. Safety equipment utilized. | | |
| 2. Selected material specified. | | |
| 3. Grinder set up: | | |
| Wheels dressed and trued | | |
| Speed | | |
| Feed rate | | |
| Depth of cut | | |
| 4. Work mounted correctly. | | |
| 5. Work ground to specifications. | | |
| 6. Work area cleaned. | | |
| | | |

# Student Competency Sheet

## Unit IX: OPERATING GRINDING MACHINES

### Module B: Grinding Operations

### Task 6: SET UP, GRIND, AND SHARPEN PRESHAPED LATHE TOOLS - TOOL GRINDER

---

## Performance Checklist

1. Set up tool grinder:
    a. Check wheel for cracks.
    b. Secure all guards.
    c. Adjust and secure tool rest.
    d. Dress and true wheel.
2. Determine lathe tool contour:
    a. Identify work piece material.
    b. Identify type of cut (rough/finish).
    c. Identify from table required rake and clearance angle.
3. Grind lathe tool to desired contour:
    a. Adjust and secure tool rest.
    b. Locate cutting edge and grind.
    c. Grind rake and clearance angles.
    d. Measure angles and inspect for sharpness.
    e. Repeat steps b to d above until desired contour of tool is obtained.

## Test

Items Needed:
1. Blueprint
2. Reference handbook
3. Tool grinder
4. Diamond point dresser
5. Preshaped lathe tool
6. Clearance and cutting angle gauge
7. Bevel protractor

Task:
1. Set up tool grinder.
2. Grind and sharpen a preshaped lathe tool to perform the machining operation specified by the blueprint.

Standard: Lathe tool contour must meet table requirements, with angular dimensions within $\pm\frac{1}{2}^{\circ}$.

---

Learning Activities

1. Read both of the following:

    a. Turning Technology-Engine and Turret Lathes (Krar/Oswald), pp. 42-47.
    b. Grinder manufacturer's operation manual.

2. Observe demonstrations by instructor of sharpening the following:

    a. Left-hand turning tool
    b. Round-nose turning tool
    c. Right-hand turning tool
    d. Left-hand facing tool
    e. Threading tool
    f. Right-hand facing tool
    g. Cut-off tool

3. Make sketches of the lathe tools. Label angles by name and degree of angle.

4. In Safety Notebook, write:

    a. Five (5) personal safety practices.
    b. Five (5) general shop safety practices.

5. Practice sharpening lathe cutter bits.

6. Obtain job work order for grinding a cutter bit:

    a. Select safety equipment.
    b. Set up grinder.
    c. Sharpen bit to specifications.
    d. Clean up work area.
    e. Have instructor evaluate your work.

## Student Competency Sheet

Unit IX: OPERATING GRINDING MACHINES

Module B: Grinding Operations

Task 7: SET UP GRINDER AND SHARPEN PLAIN MILLING CUTTERS - UNIVERSAL GRINDER

---

### Performance Checklist

1. Set grinding machine for straight cylindrical grinding:
    a. Mount cutter on suitable mandrel.
    b. Check grinding wheel for cracks.
    c. Dress and true grinding wheel.
    d. Mount cutter and mandrel between centers of machine.
    e. Align center of cutter to centers of machine.
    f. Secure and align tooth rest bracket.
2. Observe all safety practices.
3. Take light cut (approximately 0.002" deep) on first tooth to be sharpened.
4. Rotate cutter upward to sharpen next tooth.
5. Repeat steps 3 to 4 until all teeth have been ground.
6. Inspect all cutter teeth for sharpness.
7. Take a second cut, if necessary, to reach desired sharpness.
8. Repeat steps 3 to 7 until desired degree of sharpness is obtained.

### Test

Items Needed:
1. Machinist's handbook
2. Reference tables
3. Universal grinding machine
4. Plain milling cutter
5. Mandrel
6. Diamond point dresser
7. Swivel type or spring type tooth rest bracket

Task:
1. Follow all steps in the Performance Checklist to set up the grinder.
2. Sharpen the plain milling cutter to table specifications.

Standard:
1. Remove 0.006" to 0.010" from flat face of cutter.
2. Maintain a clearance angle of 4° to 7°, depending upon cutter size and table specifications.

---

## Learning Activities

1. Read both of the following:

    a. Grinding Technology (Krar/Oswald), pp. 200-203.
    b. Universal grinder manufacturer's operation manual.

2. Observe demonstration by instructor:

    a. Setting up a universal grinder.
    b. Grinding plain milling cutters.

3. In Safety Notebook, write:

    a. Five (5) personal safety practices.
    b. Five (5) general shop safety practices.

4. Sketch plain milling cutter; label angles.

5. Practice sharpening/operation using a universal grinder, as assigned by instructor.

6. Write a checklist for sharpening plain milling cutters. Discuss with partner or class and with instructor.

7. Sharpen a plain milling cutter with a universal grinder. Have your instructor evaluate your work.

## Student Competency Sheet

Unit IX: OPERATING GRINDING MACHINES

Module B: Grinding Operations

Task 8: SET UP GRINDER AND SHAPE COLD CHISELS - TOOL GRINDER

---

### Performance Checklist

1. Set up grinder:
   a. Check wheel for cracks.
   b. Secure all guards.
   c. Adjust and secure tool rest.
   d. Dress and true wheel.
2. Shape Chisel:
   a. Grind chisel head to remove mushroom head (if applicable).
   b. Grind to desired angle.
   c. Measure angle.
   d. Regrind, if necessary.
   e. Grind cutting edge convex.

### Test

Items Needed:
1. Tool grinder
2. Wheel dresser
3. Chisel
4. Machinist's square
5. Bevel protractor

Task:
1. Set up tool grinder.
2. Shape chisel to an included angle of from 60 to 70 degrees.

Standard: Chisel must be shaped to an included angle of from 60° to 70°.

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### Learning Activities

1. Read:

   a. Machining Fundamentals (Walker), pp. 70 and 121-126.
   b. Metalwork Technology and Practices (Ludwig/McCarthy), pp. 101-105 and 413-414.

2. Observe demonstration by instructor:

   a. Setting tool rest.
   b. Dressing and truing wheel.
   c. Sharpening cold chisels.

3. In Safety Notebook, write:
   a. Five (5) personal safety practices.
   b. Five (5) general shop safety practices.
4. Research and sketch shapes of various cold chisels and punches. Mark angle degrees.
5. Practice grinding cold chisels.
6. Obtain job work order from instructor:
   a. Select safety equipment.
   b. Obtain chisel to be sharpened.
   c. Set up grinder.
   d. Select coolant.
   e. Perform sharpening operation.
   f. Clean up work area.
   g. Submit work piece to instructor for evaluation.

INSTRUCTOR CHECK SHEET - SHAPE COLD CHISELS ON TOOL GRINDER

| | RATING | |
|---|---|---|
| ACTIVITIES | ACCEPTABLE | NOT ACCEPTABLE |
| 1. Safety equipment utilized. | | |
| 2. Wheels checked for damage. | | |
| 3. Tool rest set. | | |
| 4. Wheels dressed and trued. | | |
| 5. Tool rest set for angle. | | |
| 6. Coolant available. | | |
| 7. Chisel ground correctly. | | |
| 8. Work area cleaned. | | |
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## Student Competency Sheet

Unit IX: OPERATING GRINDING MACHINES

Module C: Using Abrasive Belt Grinder

Task 1: SET UP ABRASIVE BELT GRINDER

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### Performance Checklist

1. Inspect grinder for safety and operative condition.
2. Select abrasives and attachments.
3. Secure abrasive belt.
4. Secure attachments.
5. Secure work piece.

### Test

Items Needed:
1. Abrasive belt grinder and attachments
2. Abrasive belts assortment
3. Work piece

Task:
1. Select attachments.
2. Select abrasive.
3. Set up grinder and work piece.

Standard:
1. Belt grinder will be set up correctly with all safety equipment.
2. Work will be secured correctly.

---

### Learning Activities

1. Read one of the following:
    a. Manufacturer's operation manual.
    b. Machining Fundamentals, (Walker), pp. 308-310.
2. Observe demonstration by instructor:
    a. Belt selection
    b. Setting up abrasive belt grinder.
    c. Mounting work on abrasive grinder.
3. In Safety Notebook, write:
    a. Five personal safety practices.
    b. Five general shop safety practices.

4. Research and write a report on abrasive belts.

5. Practice setting up abrasive belt grinder.

6. Obtain job work order from instructor:

   a. Select safety equipment.
   b. Select abrasive belt to be used.
   c. Mount abrasive belt and align.
   d. Mount work.
   e. Have instructor evaluate set-up.
   f. Clean up work area.

INSTRUCTOR CHECK SHEET - SET UP ABRASIVE BELT GRINDER

| ACTIVITIES | RATING | |
|---|---|---|
| | ACCEPTABLE | NOT ACCEPTABLE |
| 1. Safety equipment utilized. | | |
| 2. Correct belt selected. | | |
| 3. Belt mounted and aligned. | | |
| 4. Attachments mounted correctly. | | |
| 5. Work securely mounted. | | |
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## Student Competency Sheet

## Unit IX: OPERATING GRINDING MACHINES

### Module C: Using Abrasive Belt Grinder

### Task 2: USE ABRASIVE BELT GRINDER

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### Performance Checklist

1. Inspect grinder for safety and operative conditions.
2. Inspect operator's safety equipment.
3. Select abrasive and attachments.
4. Secure abrasive belt; align belt.
5. Secure attachment; align attachment.
6. Secure work piece.
7. Grind to specifications.

### Test

Items Needed:
1. Blue print
2. Work piece
3. Abrasive belt grinder
4. Grinding attachments
5. Assortment of abrasives
6. Table of abrasives

Task:
1. Select attachments and abrasives.
2. Use utility grinder to grind work piece to blueprint specifications.

Standard: Work piece must be ground to blueprint specifications.

---

### Learning Activities

1. Read the manufacturer's operation manual.

2. Observe demonstration by instructor:

   a. Setting up abrasive belt grinder.
   b. Selecting abrasive belt.
   c. Grinding work piece to specification on abrasive belt grinder.

3. In Safety Notebook, write:

   a. Three personal safety practices.
   b. Three general shop safety practice.

4. Practice setting up and using abrasive belt grinder.

5. Obtain job work order from instructor:

   a. Select safety equipment.
   b. Obtain material to be ground.
   c. Select abrasive belt.
   d. Mount belt and work piece.
   e. Grind to specifications.
   f. Clean up work area.
   g. Submit work piece to instructor for evaluation.

INSTRUCTOR CHECK SHEET - USE OF ABRASIVE BELT GRINDER

| ACTIVITIES | RATING | |
|---|---|---|
| | ACCEPTABLE | NOT ACCEPTABLE |
| 1. Safety equipment utilized. | | |
| 2. Belt selection correct. | | |
| 3. Belt mounted and aligned. | | |
| 4. Work piece mounted correctly. | | |
| 5. Work piece ground to specifications. | | |
| 6. Work area cleaned. | | |
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# Student Competency Sheet

## Unit IX: OPERATING GRINDING MACHINES

### Module D: Grinding Equipment Maintenance

### Task 1: STORE GRINDING WHEELS

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Performance Checklist

1. Hand carry or transport grinding wheels to storage area with proper support by truck or conveyor.
2. Store wheels in dry area with protection from excessive temperature and humidity.
3. Store wheels in appropriate racks or places.
4. Store wheels in order from oldest to newest.
5. Protect wheels from impact damage.

Test

Items Needed:
1. Assortment of grinding wheels
2. Storage area

Task: Store grinding wheels.

Standard:
1. All wheels must be stored in proper place and order.
2. All activities on the Performance Checklist must be rated by your instructor as satisfactorily performed.

---

Learning Activities

1. Read one of the following:
    a. Grinding Technology (Krar/Oswald), pp. 60-63.
    b. Machining Fundamentals (Walker), pp. 121-125, and 291-294.
    c. Metalwork Technology and Practices (Ludwig/McCarthy), pp. 396-402.
2. Read Machinery's Handbook, pp. 2004-2005--"Handling, Storage and Inspection."
3. Attend lecture-demonstrations by instructor:
    a. Types of grinding wheels.
    b. Handling grind wheels.
    c. Storage of grinding wheels.
4. Write a report on the possible results from excessive temperatures, humidity and impact damage.
5. Store selection of grinding wheels, as assigned by instructor.

# Student Competency Sheet

## Unit IX: OPERATING GRINDING MACHINES

### Module D: Grinding Equipment Maintenance

### Task 2: PERFORM PREVENTIVE MAINTENANCE ON GRINDER

---

Performance Checklist

1. Clean and lubricate grinding machine.
2. Test (ring test) wheel for cracks, check flanges for burr, blotter.
3. Replace wheel if cracked.
4. Inspect bearings and spindle.
5. Check exhaust system connections, if applicable.
6. Inspect wheel guards.
7. Inspect boundary of guard opening; adjust, if necessary.

Test

Items Needed:

1. Machinery's Handbook
2. Manufacturer's specifications
3. Cleaner
4. Rawhide mallet
5. Hand tools

Task:

1. Inspect grinder for safe and operative conditions.
2. Clean and lubricate grinder, according to manufacturer's specifications.

Standard:

1. Inspection must be according to Machinery's Handbook specifications.
2. All necessary repairs must be made.
3. Grinder must be cleaned and lubricated, according to manufacturer's specifications.
4. All activities on the Performance Check Sheet must be rated by your instructor as satisfactorily performed.

---

Learning Activities

1. Read one of the following:
   a. Grinding Technology (Krar/Oswald), pp. 60-80, 94-97, 140, 184-187, and 224.
   b. Machining Fundamentals (Walker), pp. 287-311.

2. Read Machinery's Handbook, pp. 1975-2030.

3. Read manufacturer's maintenance manual.

4. Attend lecture-demonstrations by instructor:

    a. Grinders maintenance:
        (1) Tool grinders
        (2) Surface grinders
        (3) Cylindrical grinder
        (4) Centerless grinder
    b. Grinding wheels:
        (1) Handling and care of
        (2) Testing for safety
        (3) Balancing
        (4) Dressing and truing

5. Perform maintenance of grinders, as assigned by the instructor:

    a. Use attached checklist (Instructor Check Sheet).
    b. Have instructor evaluate your performance.

INSTRUCTOR CHECK SHEET - PERFORM MAINTENANCE ON THE GRINDER

| ACTIVITIES | RATING * | |
|---|---|---|
| | ACCEPTABLE | NOT ACCEPTABLE |
| 1. Cleaned grinding machine. | | |
| 2. Lubricate grinding machine. | | |
| 3. Ring tested wheel for cracks. | | |
| 4. Checked flanges for burr, blotter. | | |
| 5. Replaced wheel (if cracked). | | |
| 6. Inspected bearings and spindle. | | |
| 7. Checked exhaust system connections (if applicable). | | |
| 8. Inspected wheel guards. | | |
| 9. Inspected boundary of guard opening. | | |
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*All activities should be performed acceptably.

## Student Competency Sheet

Unit IX: OPERATING GRINDING MACHINES

Module D: Grinding Equipment Maintenance

Task 3: INSPECT GRINDER FOR SAFE OPERATION

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### Performance Checklist

1. Grinder is in proper repair.
2. All guards in place and functional.
3. Work mounted correctly.
4. Wheels mounted correctly and inspected for damage.
5. Speed and wheel rpm in agreement.

### Test

Items Needed: 1. Grinder set-up in operation

Task: Inspect for operation and safety.

Standard:
1. All safety regulations will be in conformance.
2. Grinder will be in safe operational condition.

---

### Learning Activities

1. Read two of the following:
    a. Machining Fundamentals (Walker), pp. 121-126, and 287-312.
    b. Machinists Library; Basic Machine Shop (Black), pp. 153-184, and 211-224.
    c. Metalwork Technology and Practices (Ludwig/McCarthy), pp. 397-418 and 565-581.
2. Read Machinery's Handbook (Oberg/Jones/Horton), pp. 2004-2007 and 1975-2030.
3. Attend lecture-demonstrations by instructor:
    a. Grinding wheels.
    b. Tool grinder operation.
    c. Surface grinder operation.
    d. Cylindrical grinder operation.

4. In Safety Notebook, write:
    a. Ten personal safety practice for using grinders.
    b. Ten general shop safety practices.

5. Read and discuss Information Sheet IX-D-3 (Surface Grinder Safety).

6. Research and write safety check lists for using:
    a. Tool grinder.
    b. Surface grinder.
    c. Cylindrical grinders.

7. Inspect a grinder operational set-up using the checklist you developed.

INSTRUCTOR CHECK SHEET - GRINDER SAFETY

| | RATING | |
|---|---|---|
| ACTIVITIES | ACCEPTABLE | NOT ACCEPTABLE |
| 1. Electrical controls. | | |
| 2. Wheels | | |
| damaged | | |
| dressed and true | | |
| balance | | |
| mounting | | |
| 3. Work piece | | |
| aligned | | |
| secured | | |
| 4. Speed (RPM). | | |
| 5. Feed rate. | | |
| 6. Guards functional. | | |
| 7. Operator safety equipment. | | |
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## Information Sheet IX-D-3

## SURFACE GRINDER SAFETY

1. Always wear eye protection devices when performing any grinding operation.
2. Become thoroughly familiar with all electrical and mechanical equipment necessary for the operation of the machine.
3. Do not attempt to use the grinder unless the wheel guard is in place and well secured.
4. Always check the grinding wheel for soundness before mounting it on the spindle.
5. For all dry grinding operations, be sure to use a good dust collecting system.
6. If a magnetic chuck is used, make sure the magnetic chuck is holding the work securely before starting the machine.
7. Never attempt to remove work from magnetic chuck or table of machine until the grinding wheel has come to a complete stop.
8. Keep all tools clear of work table.
9. Do not permit grinding wheel to become too badly loaded or glazed before dressing it.
10. Avoid grinding on the side of wheel. Side pressure may break the wheel.
11. Stop grinder if grinding wheel chatters or vibrates excessively. This may be a signal that the wheel is not balanced properly or is loose on the spindle.
12. Use clamps or vise when grinding small or short pieces on a magnetic chuck.
13. Move the table, using hand wheel for table movement, to see that work clears the wheel before starting the machine.
14. Never operate a grinding wheel at speeds exceeding those recommended by the manufacturer.

## INSTRUCTOR CHECK SHEET - SAFETY INSPECTION - GRINDING MACHINE

| ACTIVITIES | RATING | |
|---|---|---|
| | ACCEPTABLE | NOT ACCEPTABLE |
| 1. Proper machine set-up, prior to starting the machine. | | |
| 2. Proper use of work-holding devices. | | |
| 3. Safe operation of wheel. | | |
| 4. Placement of tools at the machine area. | | |
| 5. Grinding wheel condition. | | |
| 6. Machine guard placement. | | |
| 7. Proper dress for grinding operation being done. | | |
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# UNIT X

# OPERATING MILLING MACHINES

## Terminal Objectives

Upon completion of the modules in this unit, you will be able to:

- Inspect a milling machine for safe operation
- Perform preventive maintenance on a milling machine
- Align milling machine attachments
- Align vertical milling machine attachments
- Select and set speeds and feeds for milling work
- Drill and bore holes with a milling machine
- Perform reaming operations
- Bore to remove damaged bushing and to finish bushing
- Square metal, using a table vise and a dividing head
- Mill an angle
- Perform end milling
- Perform straddle milling operations on the horizontal mill
- Mill cylindrical work
- Mill an external radius
- Mill gears
- Perform form milling
- Perform cutting-off and flycutting operations
- Cut an external keyway
- Duplicate on the profile milling machine

## Student Competency Sheet

Unit X: OPERATING MILLING MACHINES

Module A: Setting Up

Task 1: ALIGN MILLING MACHINE ATTACHMENTS

---

### Performance Checklist

1. Clean and place vise on bed.
2. Align vise by sight.
3. Fasten vise to bed with clamping bolts.
4. Place dial indicator attachment in mill spindle or magnetic tool holder.
5. Fasten dial indicator to attachment.
6. Indicate the fixed vise jaw.
7. Secure clamp bolts.
8. Recheck with indicator.

### Test

Items Needed:

1. Vise
2. Clamping bolts
3. Wrench
4. Dial indicator attachments
5. Plastic mallet
6. Milling machine

Task:

1. Align vise on milling machine bed or on table of milling machine.
2. Use dial indicator to test alignment of vise to within 0.001" total runout.

Standard: Vise must be aligned to within 0.001" total runout.

---

### Learning Activities

1. Read two (2) of the following:
   a. Machining Fundamentals (Walker), pp. 229-286.
   b. Machinists Library; Basic Machine Shop (Black), pp.369-405.
   c. Metalwork Technology and Practices (Ludwig/McCarthy), pp. 524-564.
2. Read the manufacturer's operation manual.

3. Attend lecture-demonstration by instructor:
    a. Types of milling machines
    b. Types of cutters
    c. Attachments and fixtures
    d. Setting up a milling machine

4. In Safety Notebook, write:
    a. Five (5) personal safety practices.
    b. Ten (10) general shop safety practices.

5. Write a list of different types of vises available for the milling machine.

6. Obtain a job work fixture to be attached to the milling machine:
    a. Determine how fixture or attachment is to function.
    b. Select safety equipment.
    c. Select tools.
    d. Clean bed and vise.
    e. Align using dial indicator.
    f. Have instructor evaluate set-up.
    g. Clean up work area.

## INSTRUCTOR CHECK SHEET - ALIGN MILLING MACHINE ATTACHMENT -VISE

| | RATING | |
|---|---|---|
| ACTIVITIES | ACCEPTABLE | NOT ACCEPTABLE |
| 1. Safety equipment utilized. | | |
| 2. Cleaned bed of milling machine. | | |
| 3. Cleaned vise. | | |
| 4. Sight-aligned vise on bed. | | |
| 5. Fastened vise to bed. | | |
| 6. Placed dial indicator in mill spindle. | | |
| 7. Fastened dial indicator to attachment. | | |
| 8. Bolts (clamps) secured. | | |
| 9. Vise aligned within 0.001" tolerance. | | |
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## Student Competency Sheet

Unit X: OPERATING MILLING MACHINES

Module A: Setting Up

Task 2: ALIGN MILLING MACHINE ATTACHMENTS - VERTICAL MILLING ATTACHMENTS

---

### Performance Checklist

1. Replace draw bar with extended draw bar.
2. Insert attachment driver in quill and tighten draw bar securely, being careful to align key with keyway.
3. Position indicating surface parallel with table movement
4. Attach magnetic base with dial indicator.
5. Indicate the milling attachment for parallel alignment with table movement.
6. Secure housing clamp bolts.
7. Recheck step 5 for accuracy.

### Test

Items Needed:

1. Vertical milling attachment
2. Extended draw bar
3. Magnetic base post
4. Dial indicator
5. Plastic mallet
6. Hex wrench
7. Mill wrench
8. Horizontal milling machine

Task: Using the horizontal milling machine, mount and align the vertical milling attachment to within 0.001" per 4".

Standard: Attachment must be aligned to within 0.001" per 4".

---

### Learning Activities

1. Read manufacturer's operation manual for installing vertical milling attachment.

2. Observe a demonstration by instructor.

3. In Safety Notebook, write:

   a. Five (5) personal safety practices.
   b. Five (5) general shop safety practices.

4. Write up a procedure for mounting a vertical milling attachment on a horizontal milling machine. Have procedure checked by instructor.

5. Practice setting up vertical milling attachment using your procedure write-up.

6. Set up vertical milling attachment. Have instructor evaluate procedure and final set-up.

## Student Competency Sheet

Unit X: OPERATING MILLING MACHINES

Module A: Setting Up

Task 3: SELECT AND SET SPEEDS AND FEEDS FOR MILLING WORK

---

### Performance Checklist

Speed
1. Identify and classify material to be machined.
2. Identify cutter to be used.
3. Determine condition of milling machine.
4. Determine depth of cut to be taken.
5. Establish material cutting speed.
6. Determine speed setting for machine using handbook tables.
7. Set up speed according to operation manual.

Feed
1. Repeat steps 1-4 under Speed.
2. Determine appropriate feed, using handbook tables.
3. Set up feed according to operation manual.

### Test

Items Needed:
1. Blueprint
2. Manufacturer's operation manual for milling machine
3. Machinist's handbook
4. Milling machine

Task:
1. Determine speed and feed for milling operation according to blueprint specifications.
2. Set machine speed and feed according to operation manual.

Standard:
1. Speed and feed selection must be correct to meet blueprint specifications.
2. Speed and feed must be set according to the operation manual.

---

### Learning Activities

1. Read one (1) of the following:

   a. Machining Fundamentals (Walker), pp. 251-253.
   b. Machinists Library; Basic Machine Shop (Black), pp. 395-399.
   c. Metalwork Technology and Practices (Ludwig/McCarthy), pp. 548-552.

2. Read the manufacturer's instruction manual for speeds and feeds.

3. Attend a lecture-demonstration by instructor:

   a. Determining cutter speeds and RPM.
   b. Rate of feed.
   c. Depth of cuts.
   d. Setting speed and feed rates.

4. Write a definition for the following:

   a. RPM
   b. FPM
   c. FTR
   d. $RPM = \frac{FPM \times 12}{\pi D}$
   e. F = FTR x T x RPM

5. Study Information Sheet X-A-3 (Sample Problems).

6. Obtain problems from instructor:

   a. Practice calculating milling machine speeds and feeds.
   b. Have instructor check your work.
   c. Practice setting up milling machine, using set-up specs from the problems.

7. Obtain work piece from instructor:

   a. Identify material.
   b. Identify cutter to be used.
   c. Determine depth of cut.
   d. Determine cutting speed; set milling machine.
   e. Determine rate of feed; and set milling machine.
   f. Have instructor evaluate set-up and calculations.

Information Sheet X-A-3

Sample Problem

DETERMINE THE APPROXIMATE CUTTING SPEED AND FEED FOR A 4" DIAMETER HEAVY DUTY MILL CUTTER (HSS) WITH 14 TEETH, MILLING ALUMINUM.

| | | |
|---|---|---|
| *Recommended cutting speed for aluminum | (FPM) - | .700 FPM |
| *Recommended feed per tooth | (FTR) | 0.016" |
| Diameter of cutter | (D) | 4" |
| Number of teeth | (T) | 14 |

* From milling machine speed and feed charts.

Speed: $\text{RPM} = \frac{\text{FPM} \times 12}{\pi D} = \frac{700 \times 12}{3.14 \times 4} = \frac{2100}{3.14} = 668.8 \text{ RPM}$

RPM = 668.8 (Set for closest setting available on milling machine).

Feed:

$F = \text{FTR} \times T \times \text{RPM}$

$F = 0.016 \times 14 \times 668.8$

$F = 149.8$

Feed = 149.8 (Set for closest setting available on milling machine).

## Student Competency Sheet

Unit X: OPERATING MILLING MACHINES

Module B: Boring and Drilling

Task 1: DRILL HOLES WITH MILLING MACHINE

---

### Performance Checklist

1. Mount and align holding devices.
2. Secure part in holding device.
3. True in over first hole to be drilled.
4. Set machine speed.
5. Center drill work piece.
6. Drill first hold.
7. Use mill graduated dials to step over and drill subsequent holes to specifications.

### Test

Items Needed:

1. Blueprint
2. Work piece
3. Milling machine and accessories
4. Work-holding device
5. Plastic mallet
6. Dial indicator
7. Edgefinder
8. Precision measurement instruments
9. Wiggler
10. Combination drill and countersink
11. Drills
12. Drill chuck

Task: Drill holes in work piece according to blueprint specifications.

Standard: Holes must be drilled to meet blueprint specifications.

---

### Learning Activities

1. Read one (1) of the following:
   a. Machining Fundamentals (Walker), pp. 269-270.
   b. Manufacturer's operation manual.
2. Observe a demonstration by instructor on drilling on a milling machine.
3. In Safety Notebook, write:
   a. Three (3) personal safety practices.
   b. Three (3) general shop safety practices.

4. Write a procedure checklist for drilling with:
    a. A horizontal milling machine.
    b. A horizontal milling machine with a vertical attachment.
    c. A vertical milling machine.

5. Practice setting up milling machine for drilling.

6. Practice drilling operation on milling machine.

7. Obtain job work order from instructor:
    a. Select safety equipment, tools and material specified.
    b. Set up milling machine and mount work piece.
    c. Drill to specifications.
    d. Clean up work area.
    e. Submit work piece to instructor for evaluation.

## INSTRUCTOR CHECK SHEET - DRILLING ON MILLING MACHINE

| | RATING | |
|---|---|---|
| ACTIVITIES | ACCEPTABLE | NOT ACCEPTABLE |
| 1. Obtained material specified. | | |
| 2. Layout to specifications. | | |
| 3. Set up milling machine: | | |
| Speed | | |
| Feed rate | | |
| Mounted work securely | | |
| Aligned work for drilling | | |
| 4. Centered drill work piece. | | |
| 5. Step drilled. | | |
| 6. Drilled additional holes specified by | | |
| using milling machines graduated dials. | | |
| 7. Work piece drilled to specifications. | | |
| 8. Cleaned up work area. | | |
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## Student Competency Sheet

Unit X: OPERATING MILLING MACHINES

Module B: Boring and Drilling

Task 2: BORE HOLES WITH MILLING MACHINES

---

### Performance Checklist

1. Lay out hole location.
2. Secure work piece to table.
3. True mill wiggler.
4. Locate center of hole.
5. Select and set speeds and feeds as necessary.
6. Countersink work piece.
7. Drill pilot hole.
8. Drill hole to allow for clearance in boring.
9. Bore hole to dimensions.

### Test

Items Needed:

1. Blueprint
2. Work piece
3. Vertical mill and accessories
4. Holding fixtures
5. Dividers
6. Rule
7. Layout dye
8. Mill wiggler
9. Drill chuck
10. Combination drill and countersink
11. Drills
12. Boring attachments
13. Plug gauge
14. Micrometer calipers

Task: Bore hole in work piece to blueprint specifications.

Standard: If production work, an accuracy of 0.005" is required.

---

### Learning Activities

1. Read Machining Fundamentals (Walker), pp. 269-270.

2. Read the manufacturer's operation manual for boring holes with milling machine.

3. Observe demonstration by instructor:

   a. Setting up vertical milling machine for boring holes.
   b. Setting up horizontal milling machine for boring holes.
   c. Boring on a milling machine.

4. In Safety Notebook, write:

    a. Five (5) personal safety practices.
    b. Five (5) general safety practices.

5. Write a procedure for boring holes on a horizontal milling machine on a horizontal milling machine with vertical attachment, and on a vertical milling machine. Discuss with instructor.

6. Practice boring on a milling machine.

7. Obtain a job work order from instructor:

    a. Select safety equipment, tools, attachments, and materials.
    b. Calculate speeds and feed rates.
    c. Set up milling machine and work piece.
    d. Mill to specifications.
    e. Clean up work area.
    f. Submit work piece to instructor for evaluation.

INSTRUCTOR CHECK SHEET - BORING HOLES ON MILLING MACHINE

| | RATING | |
|---|---|---|
| ACTIVITIES | ACCEPTABLE | NOT ACCEPTABLE |
| 1. Safety equipment utilized. | | |
| 2. Layout to specifications. | | |
| 3. Milling machine set-up: | | |
| Speed | | |
| Feed rate | | |
| Depth of cut | | |
| Work piece mounted and aligned | | |
| 4. Located center with wiggler. | | |
| 5. Drill set-up: | | |
| Countersink | | |
| Pilot drill | | |
| Drill | | |
| 6. Boring equipment set up. | | |
| 7. Bored to specifications. | | |
| 8. Cleaned up work area. | | |
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## Student Competency Sheet

Unit X: OPERATING MILLING MACHINES

Module B: Boring and Drilling

Task 3: PERFORM REAMING OPERATIONS

---

### Performance Checklist

1. Identify and classify material of work piece.
2. Mount and align work-holding device.
3. Secure and align work piece.
4. Select and set speed and feed (repeating, as necessary).
5. Center drill work piece.
6. Drill work piece to specifications.
7. Ream hole to specifications.

### Test

Items Needed:

1. Blueprint
2. Work piece
3. Work-holding device
4. Vertical mill with accessories
5. Chuck
6. Combination drill and countersink
7. Drills
8. Reamers
9. Precision measurement instruments

Task: Follow blueprint specifications to:

1. Drill hole in work piece.
2. Ream hole in work piece.

Standard: A tolerance of +0.0001" to +0.0005" is required.

---

### Learning Activities

1. Read the manufacturer's operation manual for reaming operation.
2. Observe demonstrations by instructor:
   a. Using machine reamers.
   b. Setting up milling machine for reaming operation.
3. In Safety Notebook, write:
   a. Three (3) personal safety practices.
   b. Three (3) general shop safety practices.

4. Write up a procedure checklist for reaming on milling machines.

5. Practice setting up milling machine for reaming.

6. Obtain a job work order from instructor:

    a. Select safety equipment, tools, work piece, and attachments needed.
    b. Set up milling machine and align work piece.
    c. Drill work piece.
    d. Ream to specifications.
    e. Clean up work area.
    f. Submit work piece to instructor for evaluation.

INSTRUCTOR CHECK SHEET - PERFORMING REAMING OPERATION ON MILLING MACHINE

| | RATING | |
|---|---|---|
| ACTIVITIES | ACCEPTABLE | NOT ACCEPTABLE |
| 1. Safety equipment utilized. | | |
| 2. Set up work piece: | | |
| a. Secured | | |
| b. Aligned | | |
| 3. Set up milling machine: | | |
| a. Drilling | | |
| (1) Speed | | |
| (2) Feed rate | | |
| b. Reamer | | |
| (1) Speed | | |
| (2) Feed rate | | |
| 4. Work reamed to specification | | |
| (+0.0001 to +0.0005) | | |
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## Student Competency Sheet

Unit X: OPERATING MILLING MACHINES

Module B: Boring and Drilling

Task 4: BORE TO REMOVE DAMAGED BUSHING

---

### Performance Checklist

1. Mount and align holding device.
2. Secure work piece to holding device.
3. Mount boring attachment and true to bushing.
4. Select and mount boring tool.
5. Set speed and feed.
6. Bore to remove bushing.
7. Bore hole to new bushing specification.

### Test

Items Needed:

1. Blueprint
2. Machinery handbook
3. Work piece with frozen bushing
4. Bushings
5. Holding device
6. Mill with accessories
7. Dial indicator
8. Boring attachment
9. Boring tool
10. Plug gauge
11. Micrometer caliper

Task: Bore to remove frozen bushing from work piece.

Standard: Hole must be bored to meet the new bushing, handbook, and blueprint specifications.

---

### Learning Activities

1. Read manufacturer's operation manual.

2. Observe a demonstration by instructor of removing bushing.

3. In Safety Notebook, write:

   a. Five (5) personal safety practices.
   b. Five (5) general shop safety practices.

4. Write a procedure for removing a damaged bushing with a milling machine--vertical or horizontal. Have instructor check your procedure.

5. Practice setting up milling machine and removing damaged bushings.

6. Obtain work piece from instructor:

    a. Select safety equipment.
    b. Set up milling machine (including speed and feed).
    c. Mount work piece.
    d. Mill out damaged bushing.
    e. Clean up work area.
    f. Submit work piece to instructor for evaluation.

INSTRUCTOR CHECK SHEET - BORE TO REMOVE DAMAGED BUSHING

| ACTIVITIES | RATING | |
|---|---|---|
| | ACCEPTABLE | NOT ACCEPTABLE |
| 1. Safety equipment utilized. | | |
| 2. Identified material to be removed. | | |
| 3. Work piece mounted: | | |
| Securely | | |
| Aligned | | |
| 4. Milling machine set-up: | | |
| Speed | | |
| Feed rate | | |
| Boring attachment | | |
| Depth of cut | | |
| 5. Bushing removed. | | |
| 6. Hole bored to specification for new bushing. | | |
| 7. Work area cleaned. | | |
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## Student Competency Sheet

Unit X: OPERATING MILLING MACHINES

Module B: Boring and Drilling

Task 5: BORE TO FINISH BUSHING

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Performance Checklist

1. Mount and align holding device.
2. Secure work piece in holding device.
3. Mount boring attachment and true to hole.
4. Select and mount boring tool.
5. Set speed and feed.
6. Bore to specifications.
7. Press in bushing.
8. Repeat Steps 1 to 6.

Test

Items Needed:
1. Blueprint
2. Work piece with bushing to be bored
3. Holding device
4. Vertical mill with accessories
5. Dial indicator
6. Boring attachment
7. Boring tool
8. Precision measurement instruments

Task: Bore prepressed bushing to blueprint specifications.

Standard: Work piece must be bored according to blueprint specifications.

---

Learning Activities

1. Read both of the following:
   a. Machining Fundamentals (Walker), pp. 269-270.
   b. Manufacturer's operation manual for boring.
2. Observe demonstrations by instructor:
   a. Boring holes on a milling machine.
   b. Pressing bushings.
   c. Truing a bushing.

3. In Safety Notebook, write:
    a. Three (3) personal safety practices.
    b. Three (3) general shop safety practices.

4. Write a procedure checklist for finishing bushings by boring on milling machine. Check with partner and instructor.

5. Obtain a job work order from instructor:
    a. Select safety equipment, tools, attachments, and material specified.
    b. Set up work piece and milling machine.
    c. Calculate speeds and feed rates.
    d. Bore to specifications.
    e. Press bushing.
    f. Remount work piece.
    g. True bushing to specifications.
    h. Submit work piece to instructor for evaluation.

INSTRUCTOR CHECK SHEET - BORE TO FINISH BUSHING

| ACTIVITIES | RATING | |
|---|---|---|
| | ACCEPTABLE | NOT ACCEPTABLE |
| 1. Safety equipment utilized. | | |
| 2. Layout to specifications. | | |
| 3. Milling machine set-up: | | |
| Speed | | |
| Feed rate | | |
| Depth of cut | | |
| Work piece mounted and aligned | | |
| Boring attachment | | |
| 4. Bored to specifications. | | |
| 5. Pressed bushing. | | |
| 6. Remounted work and aligned. | | |
| 7. Milling machine set-up: | | |
| Speed | | |
| Feed rate | | |
| Depth of cut | | |
| 8. Bushing milled to specifications. | | |
| 9. Cleaned up work area. | | |
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## Student Competency Sheet

Unit X: OPERATING MILLING MACHINES

Module C: Milling

Task 1: SQUARE METAL USING TABLE VISE

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Performance Checklist

1. Identify and classify work piece material.
2. Mount and position vise.
3. Select and mount cutter.
4. Select and set up speed and feed.
5. Mount and align work piece to cutter.
6. Make first cut.
7. Turn off machine, rotate work piece to place finished side against fixed vise jaw, and secure.
8. Make second cut to depth.
9. Turn off machine, measure for accuracy and place work piece so that second finished surface is on the bottom of the vise.
10. Make third cut.
11. Turn off machine, measure for accuracy, and rotate work piece.
12. Cut remaining side.
13. Measure for squareness and accuracy.

Test

Items Needed:
1. Blueprint
2. Work piece
3. Milling machine with accessories
4. Vise
5. Shim stock
6. Mill cutter
7. Arbor
8. Soft-faced hammer
9. Square
10. Precision measurement instrument

Task: Square the work piece to blueprint specifications.

Standard: Your instructor must inspect and approve the work piece for:
1. Squareness.
2. Accuracy of cut.

---

Learning Activities

1. Read one (1) of the following:
   a. Machining Fundamentals (Walker), pp. 258-262.
   b. Metalwork Technology and Practices (Ludwig/McCarthy), pp. 548-558.

2. Read manufacturer's operation manual.

3. Observe a demonstration by instructor.

4. In Safety Notebook, write:

    a. Five (5) personal safety practices.
    b. Five (5) general shop safety practices.

5. Write a procedure for squaring stock using a table vise for a horizontal and vertical milling machine. Have instructor check your written procedure.

6. Practice squaring metal using table vise.

7. Obtain job work order from instructor:

    a. Select safety equipment, tools, and material.
    b. Set up milling machine.
    c. Calculate speed and feed rate; set milling machine.
    d. Mill metal.
    e. Clean up work area.
    f. Submit work piece to instructor for evaluation.

INSTRUCTOR CHECK SHEET - SQUARE METAL USING TABLE VICE

| ACTIVITIES | RATING | |
|---|---|---|
| | ACCEPTABLE | NOT ACCEPTABLE |
| 1. Safety equipment utilized. | | |
| 2. Identified and classified work piece material. | | |
| 3. Selected and mounted cutter. | | |
| 4. Selected and set up speed and feed. | | |
| 5. Vice mount and alignment correct. | | |
| 6. Mounted and aligned work piece. | | |
| 7. First cut. | | |
| 8. Mount for second cut. | | |
| 9. Second cut. | | |
| 10. Mount for third cut. | | |
| 11. Third cut. | | |
| 12. Mount for fourth cut. | | |
| 13. Fourth cut. | | |
| 14. Squareness. | | |
| 15. Accuracy of cut (finish). | | |
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## Student Competency Sheet

Unit X: OPERATING MILLING MACHINES

Module C. Milling

Task 2: SQUARE METAL USING DIVIDING HEAD

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Performance Checklist

1. Identify and classify work piece material.
2. Mount and position dividing head on machine table.
3. Secure dividing head in vertical position.
4. Mount and align scrap work piece in dividing head (for alignment cuts).
5. Mount and secure end mill cutter in chuck or mount and secure side cutter on arbor.
6. Select and set speed and feed.
7. Make cut to desired depth.
8. Turn off machine, rotate head 180°, turn machine back on, and make cut to desired depth.
9. Replace scrap work piece with piece to be machined.
10. Make first flat cut.
11. Make remaining cut, rotating head one-quarter turn, to final specifications.
12. Check for squareness and accuracy.

Test

Items Needed:
1. Blueprint
2. Scrap work piece
3. Milling machine with accessories
4. Dividing head
5. Chuck
6. Arbor
7. End mill cutter
8. Side cutter
9. Square
10. Soft-faced hammer
11. Precision measurement instruments

Task: Use dividing head to square up the work piece to blueprint specifications.

Standard: Your instructor must inspect and approve the finished work piece for:
1. Squareness.
2. Accuracy of cut.

---

Learning Activities

1. Read two (2) of the following:

   a. Machining Fundamentals (Walker), pp. 256-257.

   b. Machinists Library; Basic Machine Shop (Black), pp. 405-418.
   c. Metalwork Technology and Practices (Ludwig/McCarthy), p. 536.

2. Read manufacturer's operation manual for using dividing head.

3. Observe demonstration by instructor:

   a. Mounting dividing head.
   b. Squaring metal with divider head.

4. In Safety Notebook, write:

   a. Five (5) personal safety practices.
   b. Five (5) general shop safety practices.

5. Write a procedure for squaring metal with dividing head. Have instructor check your written procedure.

6. Practice squaring metal with dividing head.

7. Obtain a job work order from instructor:

   a. Select safety equipment.
   b. Select material, tools, and cutter.
   c. Select speeds and feed rate.
   d. Set up milling machine; align dividing head.
   e. Mill metal square.
   f. Clean up work area.
   g. Submit work piece to instructor for evaluation.

INSTRUCTOR CHECK SHEET - SQUARE METAL USING DIVIDING HEAD

| ACTIVITIES | RATING | |
|---|---|---|
| | ACCEPTABLE | NOT ACCEPTABLE |
| 1. Safety equipment utilized. | | |
| 2. Identified and classified work piece material. | | |
| 3. Selected and mounted cutter. | | |
| 4. Selected speed and feed. | | |
| 5. Dividing head mounted. | | |
| 6. Dividing head alignment checked. | | |
| 7. Work piece mounted. | | |
| 8. First cut. | | |
| 9. Second cut. | | |
| 10. Third cut. | | |
| 11. Fourth cut. | | |
| 12. Squareness. | | |
| 13. Accuracy of cut (finish). | | |
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## Student Competency Sheet

Unit X: OPERATING MILLING MACHINES

Module C: Milling

Task 3: MILL AN ANGLE

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Performance Checklist

1. Identify and classify material of work piece.
2. Mount and align angle plate.
3. Select and mount end cutter.
4. Select and set speed, feed, and depth of cut.
5. Make cut.
6. Check surface and tolerance specifications, making machine adjustments when necessary.
7. Measure and inspect work piece.

Test

Items Needed:

1. Blueprint
2. Pre-machined work piece
3. Mill and accessories
4. Work-holding device
5. Angle plate
6. 5-inch sine bar
7. Set of jo blocks (gauge blocks)
8. Precision measurement instruments
9. Vernier bevel protractor

Task: Mill the work piece to the angle and height specified on the blueprint.

Standard: Angular tolerance must be within ± 5 minutes.

---

Learning Activities

1. Read one (1) of the following:

   a. Machining Fundamentals (Walker), p. 240.
   b. Manufacturer's operation manual.

2. Observe demonstration by instructor for milling angles using:

   a. Horizontal milling machine.
   b. Vertical milling machine.
   c. Angle plate.
   d. Angle cutters.

   e. Sine bar.
   f. Swivel vise.
   g. Rotary table.
   h. Dividing head.
   i. Index head.

3. In Safety Notebook, write:

   a. Three (3) personal safety practices.
   b. Three (3) general shop safety practices.

4. Research and write a procedure checklist for milling angles using each of the following attachments:

   a. Angle plate
   b. Angle cutters
   c. Swivel vise
   d. Rotary table
   e. Dividing head
   f. Index head
   g. Vertical mill head attachment

5. Practice setting up mill and cutting angles using each procedure you wrote in Learning Activity #4.

6. Obtain job work order from instructor for milling an angle using an angle plate.

   a. Obtain safety equipment, tools, angle plate, and pre-machined work piece.
   b. Set up milling machine; mount angle plate and work piece.
   c. Mill to specifications.
   d. Clean up work area.
   e. Submit work piece to instructor for evaluation.

INSTRUCTOR CHECK SHEET - MILLING AND ANGLE WITH ANGLE PLATE

| ACTIVITIES | RATING | |
|---|---|---|
| | ACCEPTABLE | NOT ACCEPTABLE |
| 1. Safety equipment utilized. | | |
| 2. Identification of material. | | |
| 3. Milling machine set-up: | | |
| a. Cutter selected | | |
| b. Speed | | |
| c. Feed rate | | |
| d. Angle plate | | |
| e. Depth of cut | | |
| f. Work piece secured | | |
| 4. Work pieces: | | |
| a. Mill finish | | |
| b. Angle ± 5 minutes of specs | | |
| 5. Work area cleaned. | | |
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# Student Competency Sheet

Unit X: OPERATING MILLING MACHINES

Module C: Milling

Task 4: PERFORM END MILLING

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## Performance Checklist

1. Identify and classify material of work piece.
2. Mount and align vise.
3. Secure work piece in work-holding device.
4. Select and mount end mill.
5. Select and set speed and feed.
6. Align work piece, touch off, and set depth of cut.
7. Mill to prescribed lines, measure to assure accuracy, and make necessary adjustments.
8. Mill to specifications.

## Test

Items Needed:

1. Blueprints
2. Machinery handbook
3. Work piece with layout lines
4. Mill and accessories
5. Work-holding device
6. Plastic mallet or lead hammer
7. End mills
8. Dial indicator
9. Precision measurement instruments

Task: End mill a work piece to blueprint specifications.

Standard: Work piece must be machined to blueprint specifications.

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## Learning Activities

1. Read one of the following:
   a. Machining Fundamentals (Walker), pp. 241-243.
   b. Metalwork Technology and Practices (Ludwig/McCarthy), pp. 545-547.
2. Read the manufacturer's operation manual.

3. Observe demonstration by instructor on milling:

   a. Slots.
   b. Shoulders.
   c. Curved edges.
   d. Keyways.
   e. Pockets.

4. In Safety Notebook, write:

   a. Three personal safety practices.
   b. Three general shop safety practices.

5. Compile a list of types of end mills and their applications.

6. Research and write up procedure checklists for using end mills for cutting slots, shoulders, curved edges, keyways, and pockets. Have instructor check your procedures.

7. Practice milling according to procedures you wrote in Learning Activity #6. Revise written procedures (Learning Activity #6) as necessary.

8. Obtain job work order from instructor:

   a. Select safety equipment, tools, work piece, and attachments.
   b. Set up milling machine.
   c. Perform milling.
   d. Clean up work area.
   e. Submit work piece to instructor for evaluation.

INSTRUCTOR CHECK SHEET - PERFORM END MILLING

| ACTIVITIES | RATING | |
|---|---|---|
| | ACCEPTABLE | NOT ACCEPTABLE |
| 1. Safety equipment utilized. | | |
| 2. Identified material of work piece. | | |
| 3. Selected cutter required. | | |
| 4. Milling machine set-up: | | |
| Speed | | |
| Feed rate | | |
| Depth of cut | | |
| Cutter mounted and aligned | | |
| Work piece mounted and aligned | | |
| 5. Work piece: | | |
| Mill finish procedure | | |
| Milled to specifications | | |
| 6. Cleaned up work area. | | |
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## Student Competency Sheet

Unit X: OPERATING MILLING MACHINES

Module C: Milling

Task 5: PERFORM STRADDLE MILLING OPERATIONS ON THE HORIZONTAL MILL

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### Performance Checklist

1. Identify and classify material of work piece.
2. Secure vise to machine table.
3. Select, mount, measure, and align cutters.
4. Mount work piece.
5. Select and set speed and feed.
6. Align cutters to work piece.
7. Make preliminary cut.
8. Measure and make adjustments, as necessary.
9. Cut to specifications and inspect work piece.

### Test

Items Needed:

1. Blueprints
2. Milling machine with accessories
3. Vice
4. Side milling cutters
5. Milling machine arbor
6. Parallels
7. Rule
8. Square
9. Feeler gauge
10. Micrometer caliper
11. Scriber
12. Lead hammer
13. Work piece

Task: Straddle mill a work piece on the horizontal mill to an accuracy of 0.002".

Standard: Work piece must be straddle milled to an accuracy of ± 0.002" of blueprint specifications.

---

### Learning Activities

1. Read one of the following:
   a. Machining Fundamentals (Walker), pp. 264-265.
   b. Metalwork Technology and Practices (Ludwig/McCarthy), pp. 538-543.
2. Read the manufacturer's operation manual.

3. Observe demonstrations by instructor:
    a. Setting up milling machine for straddle cutting.
    b. Performing straddle milling.

4. In Safety Notebook, write:
    a. Three personal safety practices.
    b. Three general shop safety practices.

5. Research and write up a procedure checklist for gang milling. Check procedure with a partner and with instructor.

6. Practice straddle milling set-up and milling.

7. Obtain job work order from instructor:
    a. Select safety equipment, tools, cutters, accessories, and work piece.
    b. Set up milling machine.
    c. Mill work to specifications.
    d. Clean up work area.
    e. Submit work piece to instructor for evaluation.

INSTRUCTOR CHECK SHEET - STRADDLE MILLING - HORIZONTAL MILL

| | RATING | |
|---|---|---|
| ACTIVITIES | ACCEPTABLE | NOT ACCEPTABLE |
| 1. Safety equipment utilized. | | |
| 2. Identified and classified material of work piece. | | |
| 3. Layout work to blueprint specifications. | | |
| 4. Milling machine set-up: | | |
| a. Cutter selection | | |
| b. Spacer and alignment | | |
| c. Speed | | |
| d. Feed rate | | |
| e. Depth of cut | | |
| f. Work piece mounted | | |
| 5. Work piece: | | |
| a. Mounted and aligned. | | |
| b. Milled to specifications ±0.002. | | |
| c. Milled finish. | | |
| 6. Cleaned up work area. | | |
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## Student Competency Sheet

Unit X: OPERATING MILLING MACHINES

Module C: Milling

Task 6: MILL CYLINDRICAL WORK

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### Performance Checklist

1. Identify and classify material of work piece.
2. Clamp and align hold down devise.
3. Clamp and align work piece.
4. Select and mount cutter or tool.
5. Select and set speed, feed, and depth of cut.
6. Touch-off and mill to specifications.
7. Inspect surface and measure work piece for accuracy.

### Test

Items Needed:
1. Blueprints
2. Cylindrical work piece
3. Mill and accessories
4. Work-holding devices
5. Cutter and/or tool
6. Precision measurement instruments

Task: Mill a cylindrical work piece to blueprint specifications.

Standard: The cylindrical work piece must be milled to meet blueprint specifications.

---

### Learning Activities

1. Read:
    - a. Machining Fundamentals (Walker), pp. 266-267.
    - b. Manufacturers operation manual.
2. Observe demonstration by instructor.
    - a. Mounting cylindrical work on milling machine:
        - (1) Swivel vise
        - (2) Dividing head
        - (3) Universal vise
    - b. Milling cylindrical shapes

3. In Safety Notebook, write:
    a. Three personal safety practices.
    b. Three general shop safety practices.

4. Research and write up procedure checklist for milling cylindrical shaped work pieces.

5. Practice milling cylindrical work.

6. Obtain job work order from instructor:
    a. Select safety equipment, tools, attachments, and preformed work piece.
    b. Identify material to be milled.
    c. Select cutter, speed, feed rate, and depth of cut.
    d. Set up milling machine and work piece.
    e. Mill to specifications.
    f. Submit work piece to instructor for evaluation.
    g. Clean up work area.

## Student Competency Sheet

Unit X: OPERATING MILLING MACHINES

Module C: Milling

Task 7: MILL AN EXTERNAL RADIUS

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### Performance Checklist

1. Identify and classify material of work piece.
2. Mount turntable.
3. Center spindle over turntable.
4. Align and clamp work piece to turntable.
5. Select and mount cutter.
6. Select and set speed, feed, and depth of cut.
7. Mill primary cut.
8. Measure work piece and readjust mill, if necessary.
9. Check surface and tolerance of work piece and mill to specifications.

### Test

Items Needed:

1. Blueprints
2. Prepared work piece
3. Mill and accessories
4. Mill wiggler
5. Turntable
6. End mill cutter
7. Straddle clamps
8. T-Bolts
9. Step blocks
10. Dial indicator
11. Vernier calipers
12. Precision measurement instruments

Task: Cut on external radius on a prepared work piece to blueprint specifications.

Standard: The milled radius must be cut to blueprint specifications within a tolerance of ± 0.005".

---

### Learning Activities

1. Read manufacturers operation manual for milling an external radius.

2. Observe demonstrations by instructor for milling external radius with:

    a. Turntable.
    b. Divider head.
    c. Corner-rounding cutter.
    d. Concave cutters.

3. In Safety Notebook, write:
    a. Three personal safety practices.
    b. Three general shop safety practices.

4. Research and write procedure checklist for milling external radius on milling machine. Discuss with instructor.

5. Practice milling external radius with:
    a. Turntable.
    b. Divider head.
    c. Corner-rounding cutter.
    d. Concave cutters.

6. Obtain job work order from instructor:
    a. Set up for cutting.
    b. Perform cutting operation to specifications.
    c. Clean up work area.
    d. Have instructor evaluate your work.

# Student Competency Sheet

Unit X: OPERATING MILLING MACHINES

Module C: Milling

Task 8: MILL GEARS

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## Performance Checklist

1. Press gear blank on mandrel.
2. Mount dividing head and tailstock on mill.
3. Secure mandrel to dividing head.
4. Select and secure cutter to mill.
5. Determine and set indexing head to correct divisions.
6. Center gear blank to cutter.
7. Select and set speed, feed, and depth of cut.
8. Cut gear to specifications.

## Test

Items Needed:

1. Blueprint
2. Machinist's handbook
3. Mill with accessories
4. Gear blank
5. Gear tooth cutter
6. Mandrel
7. Dividing head
8. Tailstock
9. Steady rest
10. Precision measurement instruments

Task: Mill gear form blank to blueprint and handbook specifications.

Standard: Gear must be milled accurately to:
1. Blueprint specifications.
2. Handbook specifications.

---

## Learning Activities

1. Read:
    a. Machining Fundamentals (Walker), pp. 271-274.
    b. Machine Shop Operation and Setups (Porter/Lascoe/Nelson), pp. 337-360.

2. Read manufacturers operation manual.

3. Attend lecture-demonstration by instructor:
    a. Gear nomenclature (types)
    b. Tooth nomenclature (parts)
    c. Gear cutters
    d. Setting up milling machine for cutting gears
    e. Dividing head attachment

4. In Safety Notebook, write:
    a. Five personal safety practices.
    b. Five general shop safety practices.

5. Practice calculating a gear indexing problem.

6. Practice setting up and milling a gear.

7. Obtain job work order from instructor:
    a. Calculate dividing or indexing head settings.
    b. Select material specified, tools, cutter, attachments, accessories, and safety equipment.
    c. Mount work piece; set up milling machine.
    d. Mill gear to specifications.
    e. Clean up work area.
    f. Submit work piece to instructor for evaluation.

INSTRUCTOR CHECK SHEET - MILLING GEARS

| ACTIVITIES | RATING | |
|---|---|---|
| | ACCEPTABLE | NOT ACCEPTABLE |
| 1. Dividing head calculations. | | |
| 2. Safety equipment utilized. | | |
| 3. Milling machine: | | |
| a. Cutter | | |
| b. Divider head mounted and aligned | | |
| c. Speed | | |
| d. Feed rate | | |
| e. Depth of cut | | |
| f. Cutter mount | | |
| 4. Workpiece: | | |
| a. Materials specified | | |
| b. Mounted on mandrel | | |
| c. Mounted on divider head and tail | | |
| d. Cut to specifications | | |
| 5. Milling: | | |
| a. Mill finish | | |
| b. Met (Machinist's) handbook specs. | | |
| 6. Work area cleaned. | | |
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## Student Competency Sheet

Unit X: OPERATING MILLING MACHINES

Module C: Milling

Task 9: PERFORM FORM MILLING

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### Performance Checklist

1. Identify and classify material of work piece.
2. Mount and align work-holding device.
3. Select and mount form ground milling cutter.
4. Secure and align work piece in work-holding device.
5. Select and set speed and feed.
6. Touch off and set depth of cut.
7. Make preliminary cut.
8. Check and measure work piece configuration.
9. Make cutting adjustments and cut to blueprint specifications.

### Test

Items Needed:
1. Blueprint
2. Work piece
3. Work-holding device
4. Milling machine and accessories
5. Form ground milling cutter
6. Dial indicator
7. Precision measurement instruments

Task: Form mill the work piece to blueprint specifications.

Standard: The work piece must be form milled according to specifications.

---

### Learning Activities

1. Read one of the following:

    a. Machining Fundamentals (Walker), p. 244.
    b. Metalwork Technology and Practices (Ludwig/McCarthy), pp. 544-545.

2. Observe demonstration by instructor:

    a. Calculating speed and feed rate for form cutters.
    b. Setting up and performing form milling.

3. In Safety Notebook, write:

    a. Five personal safety practices.
    b. Five general shop safety practices.

4. Practice setting up and form milling.

5. Write a comparison of form milling and gang milling. Discuss with class.

6. Obtain a job work order from instructor:

   a. Select cutters, tools, attachments, accessories, materials, and safety equipment.
   b. Calculate speeds and feed rate.
   c. Set up milling machine and work piece.
   d. Mill to specifications of work order.
   e. Clean up work area.
   f. Submit work piece to instructor for evaluation.

INSTRUCTOR CHECK SHEET - FORM MILLING

| ACTIVITIES | RATING | |
|---|---|---|
| | ACCEPTABLE | NOT ACCEPTABLE |
| 1. Safety equipment utilized. | | |
| 2. Milling Machine: | | |
| a. Cutter selection | | |
| b. Cutter mount | | |
| c. Speed | | |
| d. Feed rate | | |
| e. Depth of cut | | |
| f. Work-holding devise secure | | |
| 3. Work piece: | | |
| a. Material specified | | |
| b. Mounted correctly and secured | | |
| c. Cut to specifications | | |
| 4. Work area cleaned. | | |
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## Student Competency Sheet

Unit X: OPERATING MILLING MACHINES

Module C: Milling

Task 10: PERFORM CUTTING-OFF OPERATIONS

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Performance Checklist

1. Identify and classify material of work piece.
2. Mount and align work piece in work-holding device.
3. Select and mount cutter.
4. Select and set speed, feed, and depth of cut.
5. Align work piece to cutter.
6. Perform milling operation to specifications.
7. Measure finished part for accuracy.

Test

Items Needed:
1. Blueprint
2. Horizontal milling machine with accessories
3. Work piece
4. Work-holding device
5. Blocks
6. Assortment of cutters (metal-slitting saws, 1/4 staggered tooth cutter, etc.)
7. Arbor
8. Precision measurement instruments

Task: Perform cut-off operation on mill, according to blueprint specifications.

Standard: Cut-off milling operation must be performed on work piece to be accurate to specifications.

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Learning Activities

1. Read two of the following:
   - a. Machining Fundamentals (Walker), p. 241 and pp. 267-268.
   - b. Machinists Library; Basic Machine Shop (Black), pp. 300-301.
   - c. Metalwork Technology and Practices (Ludwig/McCarthy), pp. 543-544.
   - d. Machine Shop Operations and Setups (Porter/Lascoe/Nelson), pp. 336-337.
2. Read manufacturer's operation manual for cut-off work.

3. Attend lecture-demonstrations by instructor:

    a. Sawing cutters.
    b. Setting up mill for cut-off operation.
    c. Performing cut-off operation.

4. In Safety Notebook, write:

    a. Three personal safety practices.
    b. Three general shop safety practices.

5. Practice setting up and performing cut-off operation.

6. Obtain job work order from instructor:

    a. Select safety equipment, tools, cutter, and material specified.
    b. Set up mill and work piece.
    c. Perform cut-off operation to specification.
    d. Clean up work area.
    e. Submit work piece to instructor for evaluation.

INSTRUCTOR CHECK SHEET - PERFORM CUTTING-OFF OPERATION

| ACTIVITIES | RATING | |
|---|---|---|
| | ACCEPTABLE | NOT ACCEPTABLE |
| 1. Safety equipment utilized. | | |
| 2. Milling machine: | | |
| a. Work-holding devise secured | | |
| b. Speed | | |
| c. Feed rate | | |
| d. Cutter selection and mounting | | |
| e. Depth of cut | | |
| 3. Work piece: | | |
| a. Select material specified | | |
| b. Layout done to blueprint | | |
| c. Mounted and aligned | | |
| d. Milled to specifications | | |
| 4. Milling: | | |
| a. To specification | | |
| b. Mill finish | | |
| 5. Cleaned up work area. | | |
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## Student Competency Sheet

Unit X: OPERATING MILLING MACHINES

Module C: Milling

Task 11: PERFORM FLYCUTTING OPERATIONS

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### Performance Checklist

1. Identify and classify material of work piece.
2. Mount and align work-holding device.
3. Secure work piece in work-holding device.
4. Select and mount flycutter.
5. Select and set speed and feed.
6. Align cutter to work piece, touch off, and set depth of cut.
7. Make preliminary cuts.
8. Deburr.
9. Touch off and set cutter to secondary cut depth.
10. Repeat step 8.
11. Set depth of cut to blueprint specifications.
12. Make first finish cut.
13. Repeat step 8.
14. Touch off and cut to final dimension.
15. Measure for accuracy of cut.

### Test

Items Needed:
1. Blueprint
2. Work piece
3. Milling machine and accessories
4. Work-holding device
5. Plastic mallet
6. Flycutter
7. Dial indicator
8. Precision measurement instrument

Task: Fly cut a bar.

Standard: The flycutting operation must be performed to blueprint specifications so that the finished work piece is square and parallel.

---

### Learning Activities

1. Read manufacturers operation manual for using flycutter.

2. Observe lecture-demonstration by instructor:

   a. Grinding flycutter.
   b. Using a flycutter.

3. In Safety Notebook, write:
    a. Three personal safety practices.
    b. Three general shop safety practices.
4. Practice grinding and sharpening flycutters.
5. Practice flycutting on milling machine.
6. Obtain job work order from instructor:
    a. Select safety equipment, cutter bit, tools, and work piece.
    b. Grind and sharpen flycutter.
    c. Set up milling machine and work piece.
    d. Perform milling operation.
    e. Clean up work area.
    f. Submit work piece to instructor for evaluation.

## Student Competency Sheet

Unit X: OPERATING MILLING MACHINES

Module C: Milling

Task 12: CUT EXTERNAL KEYWAY

---

### Performance Checklist

1. Mount, secure, and align vise to table.
2. Select, mount, and secure cutter.
3. Set machine speed.
4. Set center line of cutter on center line of shaft, close to holding device.
5. Turn machine on and touch off.
6. Mill to prescribed depth and length.

### Test

Items Needed:
1. Blueprint
2. Milling machine and accessories
3. Work-holding device
4. Cutter
5. Work piece
6. Precision measurement instruments

Task: Mill an external keyway to blueprint specifications of depth and distance.

Standard: Accuracy required for cutting the external keyway is:
1. Depth $^{+0.005''}_{-0.000''}$
2. Length ± 0.010"
3. Center line position ± 0.005" from end of work piece

---

### Learning Activities

1. Read manufacturer's operation manual for cutting keyways.

2. Observe demonstration by instructor:

   a. Cutter selection for cutting keyways.
   b. Aligning center lines of shaft for cutting keyways.
   c. Cutting keyways.

3. In Safety Notebook, write:
   a. Three personal safety practices.
   b. Three general shop safety practices.

4. Write a procedure checklist for cutting the following:
   a. Square keyway
   b. Woodruff key
   c. Stalled keyway

5. Practice set up and cutting keyways.

6. Obtain job work order from instructor:
   a. Select safety equipment, cutter, tools, and material.
   b. Set up milling machine.
   c. Mill keyway to specifications.
   d. Clean up work area.
   e. Submit work piece to instructor for evaluation.

INSTRUCTOR CHECK SHEET - EXTERNAL KEYWAY

| ACTIVITIES | RATING | |
|---|---|---|
| | ACCEPTABLE | NOT ACCEPTABLE |
| 1. Safety equipment utilized. | | |
| 2. Milling Machine: | | |
| a. Cutter selection | | |
| b. Cutter mounted, secured, and aligned | | |
| c. Speed | | |
| d. Feed rate | | |
| e. Depth of cut | | |
| 3. Work piece: | | |
| a. Material according to specifications | | |
| b. Material identified | | |
| c. Mounted and aligned | | |
| d. Milled to specifications | | |
| 4. Mill: | | |
| Depth - 0.000 to + 0.005" | | |
| Length - ± 0.010" | | |
| 5. Cleaned work area. | | |
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## Student Competency Sheet

Unit X: OPERATING MILLING MACHINES

Module C: Milling

Task 13: DUPLICATE ON THE PROFILE MILLING MACHINE

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### Performance Checklist

1. Mount and align work-holding device.
2. Mount and align pattern holding device.
3. Mount work piece and pattern.
4. Select and mount milling cutter and stylus.
5. Adjust stylus position over pattern and work piece.
6. Select and set speed and feed.
7. Duplicate the profile.
8. Measure to determine accuracy.
9. Make adjustments, as necessary.

### Test

Items Needed:
1. Blueprint
2. Work piece blank
3. Milling machine with accessories
4. Work-holding device
5. Pattern
6. Matching stylus
7. Appropriate indicating and centering device
8. Precision measurement instruments

Task: Duplicate profile from the pattern to profile dimensions.

Standard: The profile duplication from the pattern must be within ± 0.005" of profile dimensions.

---

### Learning Activities

1. Research profile milling and tracer milling machine.

2. Read manufacturer's operation manual.

3. Attend lecture-demonstration by instructor:

   a. Pattern making
   b. Mill set up
   c. Duplicating using profile milling machine

4. In Safety Notebook, write:
    - a. Five personal safety practices.
    - b. Five general shop safety practices.
5. Practice using profile milling machine.
6. Design and produce a pattern to be used on a profile milling machine:
    - a. Demonstrate procedure to a partner.
    - b. Have instructor check your procedure.
7. Compare profile milling machine to NC system. Discuss with class.
8. Obtain job work order from instructor:
    - a. Select safety equipment, tools, cutters, and pattern.
    - b. Set up milling machine.
    - c. Perform milling operation.
    - d. Clean work area.
    - e. Submit finished work piece to instructor for evaluation.

## Student Competency Sheet

Unit X: OPERATING MILLING MACHINES

Module D: Milling Machine Maintenance

Task 1: PERFORM PREVENTIVE MAINTENANCE ON MILLING MACHINE

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### Performance Checklist

1. Inspect milling machine for maintenance/minor repairs needed.
2. Clean milling machine.
3. Lubricate milling machine.
4. Perform other routine preventive maintenance (as needed).
5. Make minor repairs and adjustments (as needed).

### Test

Items Needed:
1. Milling machine
2. Operation manual or manufacturer's specifications
3. Cleaner
4. Cleaning rags
5. Lubricant
6. Hand tools
7. Precision measurement instruments

Task: Perform preventive maintenance on milling machine, according to operation manual or manufacturer's specifications.

Standard: All activities on the Instructor Check Sheet must be rated by your instructor as satisfactorily performed.

---

### Learning Activities

1. Read one of the following:
   - a. Machining Fundamentals (Walker), pp. 229-286.
   - b. Machinists Library; Basic Machine Shop (Black), pp.379-404.
   - c. Metalwork Technology and Practices (Ludwig/McCarthy), pp. 524-564.
2. Read the manufacturer's maintenance manual.
3. Attend lecture-demonstrations by instructor:
   - a. Maintenance of horizontal milling machine
   - b. Maintenance of vertical milling machine

4. Discuss maintenance and safety procedures.

5. Watch demonstration on setting up and tearing down milling machine.

6. Under the supervision of your instructor, practice setting up and tearing down the milling machine. Demonstrate safe use of hand tools.

7. Inspect, clean, lubricate, repair, and adjust milling machine.

    a. Follow performance checklist and manufacturer's directions.
    b. Clean up.
    c. Have instructor evaluate your work.

INSTRUCTOR CHECK SHEET -MILLING MACHINE MAINTENANCE

| ACTIVITIES | RATING | |
|---|---|---|
| | ACCEPTABLE | NOT ACCEPTABLE |
| 1. Table cleaned and lubricated. | | |
| 2. Longitudinal table feed. | | |
| 3. Transverse table feed. | | |
| 4. Vertical knee feed. | | |
| 5. Inner arbor support. | | |
| 6. Outer arbor support. | | |
| 7. Spindle. | | |
| 8. Milling machine lubricated. | | |
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# Student Competency Sheet

## Unit X: OPERATING MILLING MACHINES

### Module D: Milling Machine Maintenance

### Task 2: INSPECT MILLING MACHINE FOR SAFE OPERATION

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Performance Checklist

1. Milling machine is in proper repair.
2. Work is mounted correctly.
3. Cutter selection and mounting are correct.
4. Speeds and feed rates are correctly set.

Test

Items Needed: Milling machine set up for an operation.

Task: Inspect for safety.

Standard:
1. All safety regulations will be in conformance.
2. Milling machine will be in safe operational condition.

---

Learning Activities

1. Read two of the following:
    a. Machining Fundamentals (Walker), pp. 229-286.
    b. Machinists Library; Basic Machine Shop (Black), pp. 289-326 and pp. 369-418.
    c. Metalwork Technology and Practices (Ludwig/McCarthy), pp. 524-564.

2. Read Machinery's Handbook (Oberg/Jones/Horton), pp. 1606-1633 and 1744-1787.

3. Attend lecture-demonstrations by instructor:
    a. Milling machine safety.
    b. Operating horizontal milling machine.
    c. Operating vertical milling machine.
    d. Calculating speeds and feeds of milling machines.

4. In Safety Notebook, write:
    a. Ten personal safety practices.
    b. Ten general shop safety practices.

5. Read and discuss Information Sheet X-D-2 (Milling Machine Safety).

6. Research and write a safety checklist for:

    a. Horizontal milling machine.
    b. Vertical milling machine.

7. Inspect milling machine setup using your checklist:

    a. Write all violations and recommendations for correction.
    b. Have your instructor check your findings.
    c. Make necessary corrections and adjustments to put milling machine into safety compliance.
    d. Have instructor evaluate your work.

## Information Sheet X-D-2

## MILLING MACHINE SAFETY

1. Wear approved eye protection devices while operating the milling machine.

2. Do not attempt to operate the milling machine until you are thoroughly familiar with it.

3. Check thoroughly to see if the milling cutter and arbor are secure and that the cutter and arbor are clear of the work before starting the machine.

4. Use only wrenches that properly fit the nut or bolt head. This will obviate the possibility of striking hand against the cutter or other objects, caused by the improper use of wrenches.

5. Never put on the cutter with bare hands. Always use a heavy cloth around the teeth of the cutter.

6. Avoid striking the hands on the cutter while setting up. Move the table with the work as far away from the cutter as possible.

7. Never reach over or near the rotating cutter.

8. Stop the machine before removing chips. Never attempt to remove chips with bare hands. Always use a brush.

9. Treat any small cuts and skin puncture immediately as potential infections.

10. Remove all tools from the milling machine table before starting machine.

11. Make no adjustment while the cutter is rotating.

12. Keep the floor around the machine clear of chips and wipe up spilled cutting fluid immediately.

13. Never stand in line of the rotating cutter. Always stand erect, parallel with the table.

14. Permit no one to turn on your machine for you.

15. Keep your mind on your job, and be ready at all times for any emergency.

16. Never attempt to remove heavy milling machine vises or heavy fixtures by yourself. Always solicit the aid of another person in performing this task.

INSTRUCTOR CHECK SHEET

| ACTIVITIES | RATING |  |
|---|---|---|
|  | ACCEPTABLE | NOT ACCEPTABLE |
| 1. Acceptable shop dress. |  |  |
| 2. Cutter and machine set-up. |  |  |
| 3. Use of hand tools. |  |  |
| 4. Administration of first aid. |  |  |
| 5. Removing and replacing milling machine accessories. |  |  |
| 6. Operator's attitude. |  |  |
| 7. Proper safe shop procedures for milling machine operation. |  |  |
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# UNIT XI

# PERFORMING METALWORK OPERATIONS

## Terminal Objectives

Upon completion of the modules in this unit, you will be able to:

- Determine the accuracy of precision measurement instruments with gauge blocks
- Use depth gauges
- Measure with height gauges and with sine bars
- Clamp work in a holding device
- Cut metal stock
- Operate a cylindrical grinder
- Operate a cylinder hone
- Perform bench filing
- Polish metal
- Heat treat metal
- Fabricate special metalworking tools

## Student Competency Sheet

## Unit XI: PERFORMING METALWORK OPERATIONS

### Module A: Measuring

### Task 1: DETERMINE ACCURACY OF PRECISION MEASUREMENT INSTRUMENTS WITH GAUGE BLOCKS

---

### Performance Checklist

1. Work in air-temperature-controlled room (68°F to 72°F).
2. Clean gauge blocks with oil-treated cloth.
   CAUTION: Do not overhandle or handle roughly.
3. Wring gauges together.
4. Check accuracy of micrometers, vernier micrometers, vernier calipers.
5. Wipe and store blocks.

### Test

Items Needed:
1. Gauge blocks
2. Precision measurement instruments:
   - a. Micrometer caliper
   - b. Vernier micrometer caliper
   - c. Vernier caliper
   - d. Height gauge
   - e. Telescoping micrometer

Task: Use gauge blocks to determine accuracy of three (3) selected precision measurement instruments.

Standard: A tolerance of ±0.0001" at a temperature of 68°F to 72°F is required.

---

### Learning Activities

1. Read:
   - a. Machining Fundamentals (Walker), pp. 44-46.
   - b. Metalwork Technology and Practices (Ludwig/McCarthy), pp. 434-437 and 451-452.
2. Observe demonstration by instructor:
   - a. Cleaning and handling gauge blocks.
   - b. Wringing gauge blocks.
   - c. Using gauge blocks to check accuracy of micrometers and other precision instruments.

3. Write a report on types of block gauges; include Carl E. Johansson and Jo-Blocks.

4. Use block gauges to check accuracy of:

   a. Micrometer caliper ± 0.001.
   b. Vernier micrometer caliper ± 0.0001.
   c. Vernier caliper ± 0.0001.
   d. Height gauge ± 0.0001.
   e. Telescoping micrometers.
   f. Other gauge blocks.

# Student Competency Sheet

## Unit XI: PERFORMING METALWORK OPERATIONS

### Module A: Measuring

### Task 2: USE DEPTH GAUGES

---

## Performance Checklist

### Rule Depth Gauge

1. Clean reference surfaces.
2. Slide rule as far as it will go into hole without disturbing contact of gauge head and work.
3. Tighten clamp nut.
4. Remove from hole and read depth dimension on rule at junction with gauge head.

### Micrometer Depth Gauge

1. Insert appropriate interchangeable measuring rod.
2. Project the measuring rod through finished base for a reference surface at right angles to the spindle.
3. Turn the thimble on the sleeve for accurate measurement.
4. Read depth dimension on micrometer sleeve.

## Test

Items Needed:
1. Drilled and counterbored work piece
2. Rule depth gauge
3. Micrometer depth gauge

Task:
1. Measure work piece conterbore with rule depth gauge.
2. Measure work piece counterbore with micrometer depth gauge.

Standard:
1. Measurement with rule depth gauge must be to a tolerance of ± 1/64".
2. Measurement with micrometer depth gauge must be to a tolerance of ± 0.001".

---

## Learning Activities

1. Read two (2) of the following:

   a. *Machining Fundamentals* (Walker), pp. 33-43.
   b. *Machinists Library; Basic Machine Shop* (Black), pp. 79-90 and 114-119.
   c. *Metalwork Technology and Practices* (Ludwig/McCarthy), pp. 75-82 and 448.

2. Observe demonstration by instructor:
    a. Using rule depth gauge.
    b. Using depth micrometer depth gauge.

3. Practice using depth gauges.

4. From instructor, obtain selected assortment of work pieces to be measured with depth gauges.
    a. Measure with rule depth gauge ± 1/64".
    b. Measure with micrometer depth gauge ± 0.001.
    c. Have your instructor check your readings.

# Student Competency Sheet

## Unit XI: PERFORMING METALWORK OPERATIONS

### Module A: Measuring

### Task 3: MEASURE WITH HEIGHT GAUGES

---

## Performance Checklist

1. Clean surface plate.
2. Place work piece and height gauge on surface plate.
3. Select attachments for height gauge.
4. Make layout measurements.

## Test

Items Needed:

1. Blueprint
2. Work piece
3. Height gauge
4. Cleaner
5. Scriber points
6. Gauge blocks
7. Precision measurement instruments
8. Dial indicator

Task: Use height gauge to determine accuracy of layout measurements to blueprint specifications.

Standard: Layout measurements must be accurate to a tolerance of ± 0.001".

---

## Learning Activities

1. Read one (1) of the following:
   - a. Machining Fundamentals (Walker), p. 39.
   - b. Metalwork Technology and Practices (Ludwig/McCarthy), pp. 57-58.
2. Observe demonstration by instructor:
   - a. Using vernier height gauge.
   - b. Using surface gauge to measure height.
   - c. Using scriber points to measure height.
3. Practice using height gauges.
4. Write a list of machines in the metal area that might require usage of height gauges.

5. From instructor, obtain selection of work pieces which require height measurements:

    a. Measure ± 1/64" with rule and to ± 0.001 with vernier height gauge.
    b. Have your instructor check your readings.

## Student Competency Sheet

## Unit XI: PERFORMING METALWORK OPERATIONS

### Module A: Measuring

### Task 4: MEASURE WITH SINE BAR

---

### Performance Checklist

1. Clean surface plate, gauge blocks, and sine bar.
2. Determine angle requirement.
3. Select constant for degrees and seconds.
4. Select and mount gauge blocks on surface plate.
5. Place sine bar on surface plate.
6. Place work piece against sine bar and adjust set-up to determine work piece angle.

### Test

Items Needed:

1. 5-inch sine bar
2. Surface plate
3. Gauge blocks
4. Precision measurement instruments
5. Machinist's handbook
6. Job specifications
7. Work piece

Task: Measure angle of work piece with sine bar and other associated tools.

Standard: Measurement of the angle must be within 5 minutes.

---

### Learning Activities

1. Read two (2) of the following:
    a. Machining Fundamentals (Walker), pp. 44-46.
    b. Shop Mathematics (Felker/Bradley), pp. 165-168.
    c. Basic Mathematics Simplified (Olivo/Olivo), pp. 354-362.
2. Attend lecture-demonstration by instructor:
    a. Interpreting sine tables--"Natural Trigonometric Functions."
    b. Using sine bar.
    c. Calculating sine of an angle.

3. Write definitions for:
    a. Hypotenuse
    b. Sine
    c. Included angle
    d. Adjacent side
    e. Opposite side
    f. Degree
    g. Minutes

4. Practice calculating sine angles.

5. From instructor, obtain a work piece to be measured:
    a. Use a sine bar and measure angle as required.
    b. Have your instructor check your work.

## Student Competency Sheet

Unit XI: PERFORMING METALWORK OPERATIONS

Module B: Setting Up

Task 1: CLAMP WORK IN HOLDING DEVICE

---

### Performance Checklist

1. Identify types and sizes of holding devices.
2. Identify accessories for holding device.
3. Select proper work-holding device and attachments for work piece.
4. Secure work-holding device to table.
5. Secure work piece in holding device.
6. Check for level, squareness, or angle.
7. Inspect for safety of holding device.

### Test

Items Needed:
1. Work piece
2. Work-holding device
3. Tools
4. Machine accessories

Task: Clamp the work piece in the holding device.

Standard:
1. All steps of the performance checklist must be followed.
2. Your instructor must inspect and approve the mounting of the work piece.

---

### Learning Activities

1. Read:
   a. Machining Fundamentals (Walker), pp. 67-68, 101-105, 153-155, 252-258, and 290-291.
   b. Metalwork Technology and Practices (Ludwig/McCarthy), pp. 208-212, 535-540, and 576-578.

2. Research different styles of work-holding devices.

3. Write a list of work-holding devices used for:
   a. Arbor press
   b. Bench work
   c. Drill press
   d. Electrical Discharge Machine
   e. Engine lathe

   f. Grinder:
      (1) Abrasive belt
      (2) Cylindrical
      (3) Surface
      (4) Tool
   g. Horizontal milling machine
   h. Vertical milling machine
   i. Shaper

4. Attend demonstration by instructor:

   a. Inspecting work-holding devices for safety.
   b. Mounting work securely.

5. Develop procedure checklist for work-holding devices listed in Learning Activity #3.

6. Select work piece and mounting technique.

   a. Using checklist, mount the work piece.
   b. Your checklist and mount must receive instructor's approval.

# Student Competency Sheet

Unit XI: PERFORMING METALWORK OPERATIONS

Module B: Setting Up

Task 2: CUT METAL STOCK

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## Performance Checklist

1. Read blueprint.
2. Determine accuracy required and best cutting method.
3. Select material and equipment.
4. Set up equipment.
5. Cut metal stock to specified length.
6. Clean up work area.

## Test

Items Needed:
1. Blueprint
2. Metal stock
3. Measuring instruments
4. Work-holding device
5. Cutting tools

Task: Cut metal stock to blueprint specifications.

Standard: Materials must be cut according to specifications.

---

## Learning Activities

1. Read:
   - a. *Machining Fundamentals* (Walker), pp. 72-74 and 127-134.
   - b. *Metalwork Technology and Practices* (Ludwig/McCarthy), pp. 84-89 and 90-100.
2. Observe demonstrations by instructor:
   - a. Reading blueprints and bill of materials.
   - b. Hand tools for cutting stock.
   - c. Portable power tools for cutting stock.
   - d. Power tools for cutting stock.
3. Write a list of tools used to cut stock to work length.
4. Review safety procedures for using cutting tools (hand, portable power, power).

5. Your instructor will:

   a. Demonstrate set-up, use, and care of cutting tools, or
   b. Observe your performance in using cutting tools.
      (NOTE: you may not complete this task until instructor has approved your work and safety procedures for each kind of cutting tool.)

6. Practice cutting a variety of metal stocks, as assigned by your instructor. Use:

   a. Hand tools
   b. Portable power tools
   c. Power tools

7. Obtain job work order from instructor:

   a. Obtain material specified.
   b. Determine best cutting method.
   c. Select safety equipment.
   d. Set up equipment and cut stock.
   e. Clean up work area.
   f. Submit work piece to instructor for evaluation.

## Student Competency Sheet

Unit XI: PERFORMING METALWORK OPERATIONS

Module C: Performing Fabrication Operations

Task 1: OPERATE CYLINDRICAL GRINDER

---

### Performance Checklist

1. Mount work piece.
2. Determine work piece finish.
3. Refer to machinist's handbook for basic process data.
4. Set grinder feed and speed.
5. Adjust work piece to grinding wheel.
6. Grind work piece.
7. Measure work piece for accuracy.

### Test

Items Needed:

1. Plain carbon steel (hardened) work piece
2. Blueprint for carbon steel work piece
3. Alloy steel (annealed) work piece
4. Blueprint for alloy steel work piece
5. Machinist's handbook
6. Holding devices
7. Precision measurement instruments
8. Cylindrical grinder

Task:

1. Locate and refer to the appropriate table in machinist's handbook for basic process data for cylindrical grinding for each work piece.
2. Grind the plain carbon steel work piece.
3. Grind the alloy steel work piece.

Standard: Work pieces must be ground to blueprint specifications.

---

### Learning Activities

1. Read two(2) of the following:
    a. Grinding Technology (Krar/Oswald), pp. 140-183 and 224-253.
    b. Machining Fundamentals (Walker), pp. 304-307.
    c. Metalwork Technology and Practices (Ludwig/McCarthy), pp. 566-569.
    d. Machine Shop Operations and Setups (Porter/Lascoe/Nelson), pp. 367-381.
2. Read manufacturer's operation manual for cylindrical grinder.

3. Observe lecture-demonstration by instructor:
    - a. Handling, inspection, and safety of grinding wheels.
    - b. Identifying and classifying metal.
    - c. Setting up cylindrical grinder.
    - d. Calculating speed and feed rates for cylindrical grinder.
    - e. Performing grinding operations on cylindrical grinder.
4. In Safety Notebook, write:
    - a. Five (5) personal safety practices.
    - b. Ten (10) general shop safety practices.
5. Practice setting up grinder for grinding various materials and shapes.
6. Write procedure checklist for using:
    - a. Cylindrical grinder - center type.
    - b. Cylindrical grinder - centerless type.
7. Obtain job work order from instructor:
    - a. Select tools, material specified, mounting accessories and safety equipment.
    - b. Set up grinder and work piece.
    - c. Grind to specifications.
    - d. Clean up work area.
    - e. Submit work piece to instructor for evaluation.

## INSTRUCTOR CHECK SHEET - USING CYLINDRICAL GRINDERS

| ACTIVITIES | RATING | |
|---|---|---|
| | ACCEPTABLE | NOT ACCEPTABLE |
| 1. Safety equipment utilized. | | |
| 2. Machine-grinder: | | |
| a. Wheel inspection | | |
| b. Wheel mounting | | |
| c. General set-up | | |
| d. Speed | | |
| e. Feed | | |
| f. Depth of cut | | |
| g. Coolant | | |
| 3. Workpiece: | | |
| a. Material identified | | |
| b. Mounted securely | | |
| c. Work aligned | | |
| 4. Grinding: | | |
| a. Finished | | |
| b. Ground to specifications | | |
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## Student Competency Sheet

Unit XI: PERFORMING METALWORK OPERATIONS

Module C: Performing Fabrication Operations

Task 2: OPERATE HONE - CYLINDER HONE

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### Performance Checklist

1. Secure work piece.
2. Select hones.
3. Adjust hones to work piece.
4. Hone work piece to remove stock from bore diameter.
5. Measure work piece and hone to desired size.

### Test

Items Needed:
1. Work piece with bore diameter of 2"
2. Blueprint
3. Honing tool
4. Electric drill or engine lathe
5. Holding device
6. Precision measurement instruments

Task: Hone work piece to specifications of blueprint.

Standard: The tolerance of the roundness and straightness of the honed surface must be between 0.0003" and 0.0005".

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### Learning Activities

1. Read two (2) of the following:
    a. Machining Fundamentals (Walker), pp. 193-194.
    b. Metalwork Technology and Practices (Ludwig/McCarthy), pp. 127-128 and 414.
    c. Machine Shop Operations and Setups (Porter/Lascoe/Nelson), pp. 199-201.
2. Observe demonstrations by instructor:
    a. Abrasive compounds for honing.
    b. Using cylinder honing tool.
3. In Safety Notebook, write:
    a. Three (3) personal safety practices.
    b. Three(3) general shop safety practices.

4. Compare honing, lapping, and polishing techniques.

5. Write a list of common items that are honed, lapped, or polished.

6. Practice honing work pieces to specifications provided by instructor.

7. Obtain job work order:
   a. Determine equipment needed to hone work piece.
   b. Select and set-up equipment.
   c. Hone work piece to specifications.
   d. Clean up work area.
   e. Submit work piece to instructor for evaluation.

## Student Competency Sheet

Unit XI: PERFORMING METALWORK OPERATIONS

Module C: Performing Fabrication Operations

Task 3: PERFORM BENCH FILING

---

Performance Checklist

1. Select appropriate file.
2. Check file handle.
3. Clean file.
4. Mount work piece.
5. Test flatness and/or angle of work.
6. Check for pinning.
7. File to final tolerance repeating Steps 5 and 6 as necessary.

Test

Items Needed:
1. Assortment of files
2. File chart
3. File handles
4. File card
5. Vise and false jaws
6. Steel square
7. Bevel protractor
8. Measuring instruments
9. Work piece
10. Blueprint

Task: File the work piece to blueprint specifications.

Standard: The filed work piece must be according to blueprint specifications.

---

Learning Activities

1. Read two (2) of the following:
   - a. Machine Shop Operations and Setups (Porter/Lascoe/Nelson), pp. 48-54.
   - b. Machining Fundamentals (Walker), pp. 75-78.
   - c. Machinists Library; Basic Machine Shop (Black), pp. 34-43.
   - d. Metalwork Technology and Practices (Ludwig/McCarthy), pp. 107-112.
2. Attend a lecture-demonstration by instructor:
   - a. File shapes
   - b. File cuts
   - c. File safety
   - d. Using a file and file card
   - e. Draw filing

3. Research and write a report on files.

4. Practice using the files available in your shop.

5. Obtain job work order from your instructor:

    a. Select appropriate files.
    b. Mount work piece.
    c. File to specifications of work order.
    d. Clean up work area.
    e. Submit work piece to instructor for evaluation.

## Student Competency Sheet

Unit XI: PERFORMING METALWORK OPERATIONS

Module C: Performing Fabrication Operations

Task 4: POLISH METAL

---

### Performance Checklist

1. Determine polishing method (machine and/or hand).
2. Select abrasive.
3. Examine surface of work piece.
4. Polish to blueprint specifications.

### Test

Items Needed:

1. Work piece
2. Blueprint
3. Grinder-Buffer
4. Abrasive
5. Lubricant
6. Finish scale

Task:

1. Select polishing method.
2. Polish the work piece to blueprint specifications.

Standard: Your instructor must inspect and approve the polished work piece.

---

### Learning Activities

1. Read two (2) of the following:
    - a. Machining Fundamentals (Walker), pp. 90-91, 193-194, and 322.
    - b. Metalwork Technology and Practices (Ludwig/McCarthy), pp. 122-129 and 419-421.
    - c. Turning Technology -- Engine and Turret Lathes (Krar/Oswald), pp. 90-91.
2. Attend lecture-demonstrations by instructor:
    - a. Buffing/polishing compounds.
    - b. Polishing by hand.
    - c. Polishing on lathe.
    - d. Polishing with a buffer.

3. In Safety Notebook, write:
    a. Five (5) personal safety practices.
    b. Five (5) general shop safety practices.
4. Practice polishing to specifications provided by instructor:
    a. Hand polishing.
    b. On lathe.
    c. On buffer.
5. Obtain job work order from instructor:
    a. Obtain work piece and determine best method for polishing.
    b. Select polishing compounds and safety equipment.
    c. Polish work piece to specifications.
    d. Clean up work area.
    e. Submit work piece to instructor for evaluation.

# Student Competency Sheet

## Unit XI: PERFORMING METALWORK OPERATIONS

### Module C: Performing Fabrication Operations

### Task 5: HEAT TREAT METAL

---

## Performance Checklist

1. Determine heat treatment requirements for work piece.
2. Select temperature requirements from appropriate table.
3. Select treating sequence from handbook.
4. Select and set up heat treatment equipment and accessories.
5. Observe all safety rules for heat-treating process.
6. Heat treat work piece.
7. Test work piece.

## Test

Items Needed:
1. Job specifications
2. Specified piece of tool steel
3. Heat treating equipment
4. Machinist's handbook

Task:
1. Determine appropriate heat treatment procedures.
2. Heat treat metal to job specifications.

Standard: Appropriate heat treatment must be selected and applied to meet job specifications.

---

## Learning Activities

1. Read two (2) of the following:
   - a. Machine Shop Operations and Setups (Porter/Lascoe/Nelson), pp. 416-431.
   - b. Machining Fundamentals (Walker), pp. 377-386.
   - c. Machinists Library; Toolmakers Handy Book (Black), pp. 271-280.
   - d. Metalwork Technology and Practices (Ludwig/McCarthy), pp. 357-369.

2. Compile a list of terms and definitions found in reading assignments from Learning Activity #1.

3. Observe demonstration by instructor:
   - a. Annealing
   - b. Carburizing
   - c. Case hardening
   - d. Flame hardening
   - e. Hardening
   - f. Kasenit
   - g. Normalizing

4. Write procedure checklists for process demonstrated by instructor in Learning Activity.

5. Compile a list of heat treating equipment available; indicate their application.

6. Practice heat treating. Use checklists you developed in Learning Activity #4.

7. Obtain job work order from instructor:

   a. Determine heat treatment process.
   b. Set up equipment; obtain metal specified.
   c. Heat treat to specifications.
   d. Clean up work area.
   e. Submit work piece to instructor for evaluation.

## Student Competency Sheet

Unit XI: PERFORMING METALWORK OPERATIONS

Module C: Performing Fabrication Operations

Task 6: FABRICATE SPECIAL METALWORKING TOOLS

---

Performance Checklist

1. Identify work piece material.
2. Select tool steel.
3. Select cutter configuration to perform machining operation.
4. Select grinder and accessories.
5. Set up grinder.
6. Shape cutter to perform job specifications.
7. Measure cutter for accuracy and sharpness.

Test

Items Needed:
1. Blueprint
2. Tool steel
3. Grinder
4. Precision measurement instruments

Task: Fabricate the necessary metalworking tool to blueprint specifications.

Standard:
1. The fabricated, special metalworking tool must be accurate to blueprint specifications.
2. Your instructor must inspect and approve the sharpness of the fabricated tool.

---

Learning Activities

1. Read one (1) of the following:
   a. Machining Fundamentals (Walker), pp. 299-304.
   b. Metalwork Technology and Practices (Ludwig/ McCarthy), pp. 410-417.

2. Attend lecture-demonstration by instructor:
   a. Using tool grinders.
   b. Using precision measuring gauges.
   c. Grinding and sharpening lathe cutter bits.
   d. Coolants used for grinding tool steel.

3. In Safety Notebook, write:
   a. Five (5) personal safety practices.
   b. Five (5) general shop safety practices.

4. Obtain blueprints of projects:

   a. Identify material of work piece.
   b. Identify machining required.
   c. Identify special cutters required.
   d. Determine material for cutter.
   e. Grind to shape.
   f. Trial cut with tool.
   g. Touch up cutter.
   h. Clean up work area.
   i. Have instructor check your work.

5. Your instructor will assign a project.

   a. Complete activities of Learning Activity #4.
   b. Have your instructor evaluate your work.

# UNIT XII

# DESIGNING AND PLANNING MACHINE WORK

## Terminal Objectives

Upon completion of the modules in this unit, you will be able to:

- Interpret technical orders, standards, and specifications for machine work
- Make sketches of parts to be machined
- Perform layout for precision machine work, using layout instruments
- Perform layout for precision machine work, using a milling machine

## Student Competency Sheet

## Unit XII: DESIGNING AND PLANNING MACHINE WORK

### Module A: Design

### Task 1: INTERPRET TECHNICAL ORDERS, STANDARDS, AND SPECIFICATIONS FOR MACHINE WORK

---

### Performance Checklist

1. Select print or specification.
2. Determine scale used.
3. Check notes.
4. Determine views or specifications.
5. Determine tolerances and limits.
6. Determine machine sequence.

### Test

Items Needed:
1. Technical orders
2. Standards
3. Job specifications

Task: Determine and interpret reference information to be used in performing the machine work.

Standard: Your instructor must inspect and approve your determination according to the Performance Checklist.

---

### Learning Activities

1. Read two (2) of the following:
    a. Machining Fundamentals (Walker), pp. 15-23.
    b. Machinists Library; Basic Machine Shop (Black), pp. 11-22.
    c. Metalwork Technology and Practices (Ludwig/McCarthy), pp. 35-43 and 251-254.
2. Take a course on blueprint reading (Optional).
3. Attend lecture-demonstrations by instructor:
    a. Reading blueprints (drawings).
    b. Reading and interpreting technical charts.

4. Participate in discussion on blueprint reading:

   a. Why it is important to follow directions accurately.
   b. Why mathematics skills are important in blueprint reading.

5. Interpret and discuss:

   a. Bill of materials.
   b. Identification (numbering) system for drawings.

6. Obtain from instructor: detail drawing, assembly drawing, subassembly drawing, combined detail and assembly drawing. With a partner:

   a. Study drawing(s).
   b. Identify the following:
      (1) Dimension lines
      (2) Extension lines
      (3) Center lines
      (4) Cutting plane lines
      (5) Visible object lines
      (6) Hidden object lines
      (7) Section lines
      (8) Sectional views
      (9) Conventional views
   c. Determine:
      (1) Dimensions
      (2) Materials
      (3) Finishes
      (4) Tolerances
      (5) Quantity of units
      (6) Scale
      (7) Assembly or disassembly information
      (8) Revisions
      (9) Name of object and on what it is to be used

7. Discuss how machine sequence can be determined from drawings.

8. Obtain blueprint drawing from instructor:

   a. Study drawing.
   b. Determine scale used.
   c. Determine views and specifications.
   d. Determine machine sequence.
   e. Explain steps b, c, and d to instructor.

## Student Competency Sheet

Unit XII: DESIGNING AND PLANNING MACHINE WORK

Module A: Design

Task 2: MAKE SKETCHES OF PARTS TO BE MACHINED

---

### Performance Checklist

1. Make sketch of appropriate views
2. Dimension views.
3. Specify materials.
4. Indicate finish desired on work pieces; indicate tolerances.
5. Record number of pieces of part(s) wanted.

### Test

Items Needed:
1. Specifications for part(s)
2. Drafting paper
3. 2H pencils
4. Measurement instruments
5. Rule
6. Brush
7. Eraser

Task: Make a sketch of part(s) to be machined.

Standard:
1. Sketch must be according to specifications.
2. Sketching procedures outlined in the Performance Checklist must be rated by your instructor as satisfactorily performed.

---

### Learning Activities

1. Read two (2) of the following:
   a. Machining Fundamentals (Walker), pp. 15-23 and 29-56.
   b. Machinists Library; Basic Machine Shop (Black), pp. 11-22.
   c. Metalwork Technology and Practices (Ludwig/McCarthy), pp. 35-49 and 62-66.
2. Take a course in technical drawing and blueprint reading (Optional).
3. Attend lecture-demonstration on how to print.
   a. Practice printing the letters of the alphabet.
   b. Practice printing words.
   c. Practice printing the numerals and letters that appear on illustrations in your text.
   d. Have your instructor check your work.

4. Attend lecture-demonstration by instructor:
    a. Sketching
    b. Blueprint reading
    c. Tolerances

5. Select a project to be designed and make working sketches. Include:
    a. Appropriate views.
    b. Views dimensioned and tolerances labeled.
    c. Material specified.
    d. Finish to be accomplished.
    e. Number of parts to be made.
    f. Sketch of assembled project.

6. Obtain job work order from instructor:
    a. Make a sketch of appropriate views.
    b. Include dimensions, tolerances, and material to be used.
    c. Specify number to be made.
    d. Have instructor evaluate your work.

## Student Competency Sheet

### Unit XII: DESIGNING AND PLANNING MACHINE WORK

### Module A: Design

### Task 3: PERFORM LAYOUT FOR PRECISION MACHINE WORK USING LAYOUT INSTRUMENTS

---

Performance Checklist

1. Review blueprint.
2. Cut work piece to working size.
3. Remove burrs and sharp edges.
4. Clean work piece.
5. Coat work piece with layout fluid.
6. Mount work piece.
7. Scribe reference or base line.
8. Scribe lines.
9. Check blueprint for accuracy.
10. Rescribe lines, if necessary.
11. On job specifications indicate required machining operations.

Test

Items Needed:
1. Blueprint
2. Work piece
3. Cutting tools
4. Files
5. Cleaner
6. Layout fluid
7. Mounting devices
8. Layout tools
9. Precision measurement instruments

Task:
1. Perform layout for precision machine work, according to blueprint specifications.
2. Indicate required machining operations on job specifications.

Standard:
1. The location of positions on the work piece must be within 0.001".
2. Angles must be accurate to 5 minutes.

---

Learning Activities

1. Read two (2) of the following:

   a. Machining Fundamentals (Walker), pp. 57-66.
   b. Machinists Library; Basic Machine Shop (Black), pp. 11-22.
   c. Machinists Library; Toolmakers Handy Book (Black), pp. 11-44.
   d. Metalwork Technology and Practices (Ludwig/McCarthy), pp. 35-43 and 50-72.

2. Attend lecture-demonstrations:
   - a. Reading blueprints.
   - b. Layout tools.
   - c. Layout techniques.

3. Write a list of layout tools.

4. Obtain a blueprint from instructor:
   - a. Select material specified and layout tools.
   - b. Clean metal and coat with layout fluid.
   - c. Layout work piece to specifications.
   - d. Clean work area.
   - e. Submit work piece to instructor for evaluation.

INSTRUCTOR CHECK SHEET - LAYOUT

| ACTIVITIES | RATING | |
|---|---|---|
| | ACCEPTABLE | NOT ACCEPTABLE |
| 1. Work piece cut to work size. | | |
| 2. Burrs and sharp edges removed. | | |
| 3. Cleaned work piece. | | |
| 4. Layout fluid applied. | | |
| 5. Reference line scribed. | | |
| 6. Scribed lines to blueprint specifications: | | |
| a. Lines ± 0.001" | | |
| b. Angles ± 2 1/2 minutes | | |
| 7. Work area cleaned. | | |
| | | |
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## Student Competency Sheet

## Unit XII: DESIGNING AND PLANNING MACHINE WORK

### Module A: Design

### Task 4: PERFORM LAYOUT FOR PRECISION MACHINE WORK USING MILLING MACHINE

---

### Performance Checklist

1. Review blueprint.
2. Mount edgefinder.
3. Mount work piece.
4. Locate edge with edgefinder.
5. Spot dimensions according to blueprint specifications.

### Test

Items Needed:
1. Milling machine
2. Blueprint
3. Edgefinder
4. Collet or chuck
5. Combination drill and countersink
6. Work piece

Task: Use milling machine to perform layout for precision machine work, according to blueprint specifications.

Standard: Work piece must be laid out to blueprint specifications.

---

### Learning Activities

1. Read two (2) of the following:
   a. Machining Fundamentals (Walker), pp. 229-286.
   b. Metalwork Technology and Practices (Ludwig/McCarthy), pp. 524-564.
   c. Milling machine manufacturer's operation manual.
2. Observe demonstrations by instructor:
   a. Operating milling machines.
   b. Using various table alignment feeds to lay out work on milling machines.

3. Practice using milling machine to lay out work piece.

4. Compare this technique to numerical control system. Discuss:

5. Obtain job work order from instructor:

    a. Select tools, work piece, and safety equipment.
    b. Mount work piece on milling machine.
    c. Locate reference point with edge finder.
    d. Spot dimensions to blueprint specifications.
    e. Check layout with precision measuring instruments.
    f. Have instructor evaluate layout.
    g. Clean up work area.

INSTRUCTOR CHECK SHEET

| ACTIVITIES | RATING | |
|---|---|---|
| | ACCEPTABLE | NOT ACCEPTABLE |
| 1. Safety equipment utilized. | | |
| 2. Work piece mounted. | | |
| 3. Edgefinder used to locate reference point. | | |
| 4. Dimensions spotted to specification. | | |
| 5. Work area cleaned. | | |
| | | |
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# UNIT XIII

# PERFORMING SUPERVISORY FUNCTIONS

## Terminal Objectives

Upon completion of the modules in this unit, you will be able to:

- Inventory supplies and materials
- Order and receive stock shipments
- Supervise the maintenance of shop safety equipment, safe operations in the shop, and the set-up of machinery
- Supervise the use and operation of machines
- Conduct follow-up on product quality control standards

## Student Competency Sheet

## Unit XIII: PERFORMING SUPERVISORY FUNCTIONS

### Module A: Maintaining Supplies and Materials

### Task 1: INVENTORY SUPPLIES AND MATERIALS

---

### Performance Checklist

1. Obtain inventory records.
2. Count items on hand.
3. Record description and stock number of items.
4. Refer to reorder points to determine replacement needs.
5. Record maximum and minimum quantity and the quantity to be ordered.

### Test

Items Needed:

1. Attached stock inventory list
2. A listing of the supplies required to operate a shop (Obtain from your instructor)
3. Pencil

Task:

1. Count and record the exact quantity of supplies and materials on hand.
2. Determine and record the maximum quantity of supplies and materials to be ordered.
3. Determine and record the minimum quantity of supplies and materials to be ordered.
4. Determine and record the quantity of items to be ordered.

Standard: The complete inventory list must be checked and approved by your instructor.

---

### Learning Activities

1. Attend lecture-demonstration by instructor:
    - a. Classifying supplies and materials:
        - (1) Machines and accessories
        - (2) Portable power equipment
        - (3) Hand tools
        - (4) Consumable supplies
            - (a) Hardware
            - (b) Non-ferrous metals
            - (c) Ferrous metals
    - b. Need for inventory control.
    - c. Taking inventory using Stock Number Inventory System.

2. Visit local establishments: inquire about and observe their inventory techniques.

3. Research and compile an inventory list for:

   a. Engine lathe accessories and attachments.
   b. Milling machine accessories and attachments.
   c. Portable power equipment.
   d. Hand tools.
   e. Hardware (drills, screws, etc.)
   f. Metals.

4. Your instructor will assign an inventory to be made:

   a. Make the inventory.
   b. Complete the Stock Inventory List (Information Sheet XIII-A-1).
   c. Have your instructor check your work.

## STOCK INVENTORY LIST

### INVENTORY LIST

| DESCRIPTION AND STOCK NUMBER* | MAXIMUM QUANTITY | MINIMUM QUANTITY | QUANTITY TO BE ORDERED |
|---|---|---|---|
| | | | |
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*Stock number for internal shop identification, computer bank number, and blueprint identification number.

## Student Competency Sheet

## Unit XIII: PERFORMING SUPERVISORY FUNCTIONS

### Module A: Maintaining Supplies and Materials

### Task 2: ORDER AND RECEIVE STOCK

---

Performance Checklist

1. Determine supplies and materials needed for job.
2. Identify supplies and materials on hand.
3. Obtain needed supplies and materials.
   a. Order or reorder stock
   b. Record receiving of stock
   c. Store stock
4. Maintain requisition records.
5. Maintain records and work order files.

Test

Items Needed:
1. Inventory list
2. Information on reorder points
3. Job specifications

Task:
1. Determine the availability of supplies and materials needed for machining work.
2. Order or reorder supplies and materials needed.
3. Record stock received.
4. Update inventory records.

Standard: Each activity on the Instructor's Check Sheet must be rated acceptable by your instructor.

---

Learning Activities

1. Read one (1) of the following:
   a. General Industrial Machine Shop (Johnson), pp. 46-50.
   b. Metalwork Technology and Practices (Ludwig/McCarthy), pp. 44-48.
2. Attend lecture by instructor:
   a. Determining materials needed for a job.
   b. Ordering stock.
   c. Receiving and storing stock.
   d. Maintaining records and work files.
3. Practice writing stock orders.

4. Visit local establishments and inquire about their ordering and receiving set-up.

5. Discuss procedures for processing stock orders.

6. Obtain job work order (specifications) from instructor:

   a. Order necessary supplies which are not in stock.
   b. Process order; check stock in when it arrives.
   c. Place stock in correct storage area and complete inventory records.
   d. Have instructor check each activity as you complete it.

INSTRUCTOR CHECK SHEET - DETERMINE AVAILABILITY OF SUPPLIES AND MATERIALS NEEDED FOR MACHINING WORK

| ACTIVITIES | RATING | |
|---|---|---|
| | ACCEPTABLE | NOT ACCEPTABLE |
| 1. Determined supplies and materials needed. | | |
| 2. Identified supplies and materials on hand. | | |
| 3. Ordered or reordered stock. | | |
| 4. Recorded and stored received stock. | | |
| 5. Maintained requisition records and work order files. | | |
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*All activities should be performed acceptably.

## Student Competency Sheet

## Unit XIII: PERFORMING SUPERVISORY FUNCTIONS

### Module B: Supervising Safety and Operations

### Task 1: SUPERVISE MAINTENANCE OF SHOP SAFETY EQUIPMENT, SAFE OPERATIONS, AND SET-UP OF MACHINERY

---

### Performance Checklist

1. Read OSHA standards.
2. Inspect and maintain shop safety equipment.
3. Inspect machine safety equipment/accessories.
4. Correct personnel who are in violation of safety practices.
5. Complete required reports of safety violations.
6. File and/or process safety and accident reports.

### Test

Items Needed: Occupational Safety and Health Act (OSHA) of 1970 standards

Task: Following OSHA standards, supervise:
1. Maintenance of shop safety equipment.
2. Safe operations.
3. Set-up of machinery.

Standard: Your instructor will observe your performances which must be rated satisfactory and in compliance with OSHA standards.

---

### Learning Activities

1. Read the Occupational Safety and Health Act.

2. Read one (1) of the following:

   a. Machining Fundamentals (Walker), pp. 25-27.
   b. Metalwork Technology and Practices (Ludwig/McCarthy), pp. 29-34.
   c. General-Industrial Machine Shop (Johnson), pp. 36-40.

3. Research and compile a list of safety equipment used in the metal working area.

4. Attend lecture by instructor on:

   a. Personal safety.
   b. Equipment safety features.
   c. Inspecting equipment for safety.
   d. Reporting safety hazards (See Information Sheet XIII-B-1).
   e. Accident reports (See Information Sheet XIII-B-1a).

5. Start a file of safety equipment available.

6. Discuss Federal and State government agencies' involvement in safety:

    a. Rules/regulations (what is mandated and why).
    b. Inspections.
    c. Consequences to violators.
    d. Process for reporting violations and accidents.

7. Conduct a safety inspection of the metalworking area of your school shop.

    a. Write up any violations or hazardous conditions.
    b. Write up recommended corrections of violations or hazardous conditions.
    c. Have your instructor check your work.

8. With one (1) or two (2) partners, plan and conduct a safety briefing. Your instructor will assign the topic.

    a. Make an outline of major points to be covered.
    b. Assemble equipment and materials.
    c. Use films/demonstration/lecture/discussion methods.
    d. Plan and deliver a post-test (optional).
    e. Have the group you addressed discuss and evaluate your performance.
    f. Discuss your performance with your instructor.

## Information Sheet XIII-B-1

## HAZARDOUS CONDITIONS REPORT

This is a suggested method for reporting the hazard and directing action to see that the hazard is corrected or removed

- - - - - - - - - - - -

If a hazard exists, the operation should be "red tagged" and shut down until corrected. (NOTE: THIS FORM CAN BE USED TO REPORT A STUDENT WHO IS A HAZARD AS WELL AS A HAZARDOUS CONDITION IN THE LABORATORY.)

### HAZARDOUS CONDITIONS REPORT

Date ____________________

To: ________________________________________________
(Building Administrator) (Position) (School)

Description and Location of Health or Safety Hazard:

________________________________________________

________________________________________________

________________________________________________

Suggested Solution:

________________________________________________

________________________________________________

________________________________________________

Teacher Signature: ____________________

Distribution:
Original - Building Administrator
1st Copy - Department Chairperson
2nd Copy - Teacher Reporting Hazard
3rd Copy - District Safety Officer

Action Taken:

________________________________________________

________________________________________________

________________________________________________

By Whom: ________________________________________
(Signature)

Information Sheet XIII-B-1 (Continued)

## ACCIDENT REPORTING

Any accident that occurs during industrial arts activities and in the industrial arts shop must be reported. This applies to after school accidents as well as those during the school day. Any accident, even a slight cut, must be reported since this indicates corrective action that must be taken by the teacher, administrator, or both.

A form for the reporting of these accidents can be adapted from the one on the following page. This report should be completed in triplicate; one (1) for the principal, one (1) for the school nurse, and one (1) for the teacher's permanent file.

## ACCIDENT REPORTING AND ANALYSIS

1. Require students to report all accidents to the teacher, regardless of nature or severity.

2. Keep a record of all industrial arts accidents resulting in injury to students, regardless of nature or severity.

3. Analyze all accident reports for the purpose of aiding in the prevention of other accidents.

4. Use your school district's printed or duplicated form to record the details of accidents and forward to the appropriate personnel.

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## Information Sheet XIII-B-1

## STUDENT ACCIDENT REPORT

TO BE COMPLETED BY INSTRUCTOR:

Student Name ______________________________ Grade ________

Location of Accident ______________ Time ________ A.M. _____ / _____ P.M.
(Lab Area)

Date of Accident ______________________________

Description of Injury ______________________________

______________________________

______________________________

Location of Instructor when Accident Occurred: ______________________________

Description of How Accident Happened: ______________________________

______________________________

______________________________

Indicate Equipment, Machinery, or Tools Involved: ______________________________

Describe unsafe practices, if any, contributing to accident: ______________________________

______________________________

______________________________

Suggestions for prevention of similar accident: ______________________________

______________________________

______________________________

Witnesses to Accident: 1. ______________________________

2. ______________________________

Instructor's Signature ______________________________ Date ____________

Student's Signature ______________________________ Date ____________

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NOTE: One (1) Copy to be filed with Department Chairman

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## Student Competency Sheet

## Unit XIII: PERFORMING SUPERVISORY FUNCTIONS

### Module B: Supervising Safety and Operations

### Task 2: SUPERVISE MACHINE USE AND OPERATION

---

### Performance Checklist

1. Inspect work area condition.
2. Prescribe machine maintenance:
   a. Determine cause of down-time.
   b. Initiate repairs.
3. Insure proper machine operations.

### Test

Items Needed:
1. Work areas (equipped and in use)
2. Paper
3. Pencil
4. Job sheets for operation of shop area for work day
5. Schedule of assignments for the day

Task: Within an (8 hour) period, observe and supervise machinery use and operation.

Standard:
1. Optimum use of machinery must be maintained.
2. All items on Performance Check Sheet must be performed in a manner rated satisfactory by your instructor.

---

### Learning Activities

1. Write a job description for a supervisor.

2. Attend lecture by instructor:

   a. Shop safety.
   b. Enforcing safety practices.

3. Research responsibilities of a supervisor.

4. Obtain job sheets for operations to be accomplished in one (1) day:

   a. Analyze best use of equipment and personnel.
   b. Make assignments.
   c. Operate shop and perform supervisory functions.
   d. Have your instructor evaluate your performance.

INSTRUCTOR CHECK SHEET - SHOP SUPERVISION

| ACTIVITIES | RATING | |
|---|---|---|
| | ACCEPTABLE | NOT ACCEPTABLE |
| MACHINE OPERATIONS | | |
| 1. Understood operations to be performed. | | |
| 2. Identified any problems in work area. | | |
| 3. Determined cause of machine down-time. | | |
| 4. Initiated repairs. | | |
| 5. Insured proper machine operation. | | |
| PERSONNEL UTILIZATION | | |
| 1. Made job assignments to insure best use of equipment to perform required work. | | |
| 2. Made job assignments to insure best use of workers skills. | | |
| 3. Time allotments were realistic. | | |
| 4. Assured compliance with appropriate safety procedures. | | |
| 5. Assured quality control of products within time allotments. | | |
| SUPERVISORY STYLE | | |
| 1. Gave clear, specific directions. | | |
| 2. Recognized concerns of workers: | | |
| a. Answered questions promptly and clearly. | | |
| b. Displayed polite, considerate behavior. | | |
| c. Encouraged workers. | | |
| 3. Maintained continuity of work. | | |
| 4. Maintained safe working environment. | | |
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## Student Competency Sheet

## Unit XIII: PERFORMING SUPERVISORY FUNCTIONS

### Module C: Maintaining Quality Control

### Task 1: CONDUCT FOLLOW-UP ON PRODUCT QUALITY CONTROL STANDARDS

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### Performance Checklist

1. Determine product standards from blueprint specifications.
2. Determine which measuring instruments to use.
3. Inspect and measure each one-of-a-kind product.
4. Inspect and measure samples of mass-produced products based on quality control standards.
5. Reject or pass units according to quality control standards.

### Test

Items Needed:
1. Several finished products which have been inspected (selected by your instructor).
2. Blueprints for the finished products in #1.
3. Precision measurement instruments.

Task: Follow-up on end product quality control, according to blueprint specifications.
1. On a one-of-a-kind product, each unit must be inspected.
2. On mass-produced products, a given number (set up by your instructor) must be inspected.

Standard: Your instructor must approve your decisions to reject or pass units according to quality control standards.

---

### Learning Activities

1. Read one (1) of the following:
   a. Machining Fundamentals (Walker), pp. 327-339.
   b. Metalwork Technology and Practices (Ludwig/McCarthy), pp. 434-454.
2. Attend lecture-demonstration by instructor:
   a. Using measuring equipment and tools.
   b. Determining product standards from blue prints.
   c. Quality control standards.
3. Write a list of tools and equipment that are used for quality control.

4. Write a checklist for an item to be inspected from the blueprint.

5. Obtain several finished products to be inspected:

    a. Determine quality standards to be satisfied.
    b. Inspect work for quality.
    c. On items rejected write reason(s) for rejection.
    d. Have your instructor evaluate your performance.

INSTRUCTOR CHECK SHEET - QUALITY CONTROL

| ACTIVITIES | RATING | |
|---|---|---|
| | ACCEPTABLE | NOT ACCEPTABLE |
| 1. Material of work piece of type specified. | | |
| 2. Overall dimensions to specs. | | |
| 3. Work piece machined to specifications. | | |
| 4. Finished appearance. | | |
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## UNIT XIV

## MAINTAINING MACHINES AND TOOLS

### Terminal Objectives

Upon completion of the modules in this unit, you will be able to:

- Inspect and repair hand tools
- Clean and store hand tools, cutters, fixtures, jigs or attachments
- Store precision tools
- Install, level and fasten down machines
- Inspect and remove, replace or adjust machine guards
- Remove machine parts
- Inspect and change drive pulleys or belts
- Replace and adjust machine parts
- Select coolants, cutting oils or compounds for machine operation
- Scrape and paint machines

## Student Competency Sheet

Unit XIV: MAINTAINING MACHINES AND TOOLS

Module A: Cleaning and Storing Tools

Task 1: INSPECT AND REPAIR HAND TOOLS

---

### Performance Checklist

1. Inspect hand tool and determine damage.
2. Determine if hand tool is repairable or needs replacement.
3. Repair hand tool:
   a. Obtain needed part(s).
   b. Dismantle hand tool.
   c. Assemble hand tool with new part.
   d. Adjust, if necessary.

### Test

Items Needed:
1. Broken hand tools
2. Job specifications or manufacturer's standards

Task:
1. Inspect hand tools to determine damage.
2. Repair hand tools to job specifications or manufacturer's standards.

Standard: Your instructor must rate your performance as satisfactory.

---

### Learning Activities

1. Read:

   a. Machining Fundamentals (Walker), pp. 67-93.
   b. Metalwork Technology and Practices (Ludwig/McCarthy), pp. 50-61 and 84-121.

2. Attend lecture-demonstrations by instructor:

   a. Common damage to hand tools.
   b. Repairing hand tools.

3. Compile a list of common hand tools. List common damage to look for and repair required. Example:

| Tool | Damage | Repair |
|---|---|---|
| Metal hammer | Loose handle<br>Splintered handle<br>Chipped head | New wedges in head end<br>Replace handle<br>Replace head |

4. Obtain selected handtools to be inspected:
    a. Inspect for damage.
    b. Repair damaged hand tools.

5. Your instructor will supply at least five (5) hand tools:
    a. Inspect for damage; list condition of tool.
    b. Recommend replacement, if appropriate, or...
    c. Repair.
    d. Have instructor evaluate your work.

# Student Competency Sheet

## Unit XIV: MAINTAINING MACHINES AND TOOLS

### Module A: Cleaning and Storing Tools

### Task 2: CLEAN AND STORE HAND TOOLS, CUTTERS, FIXTURES, JIGS OR ATTACHMENTS

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Performance Checklist

1. Wipe or lightly brush away shavings, moisture, oil, or grease.
2. Inspect for damage.
3. Check for operation (if applicable) and do not force movement.
4. Wipe dry.
5. Apply light oil (if applicable).
6. Store in proper container or storage place.

Test

Items Needed:
1. Cleaning fluid
2. Rags
3. Brushes
4. Light oil
5. Storage facilities
6. Handtools
7. Cutters
8. Fixtures
9. Jigs
10. Assortment of attachments

Task:
1. Clean hand tools, cutters, fixtures, jigs and attachments.
2. Store the cleaned equipment.

Standard: Your instructor must inspect and approve your cleaning and storing activities.

---

Learning Activities

1. Read sections in a text book on tool safety and storage procedure.

2. Attend instructor's lecture-demonstrations on storing and cleaning hand tools, cutters, and fixtures.

3. In Safety Notebook, write:

   a. Five (5) personal safety practices.
   b. Five (5) general safety practices.

4. Discuss cleaning procedures and storage containers/facilities/arrangements for hand tools. Include, in discussion, the consequences of improper cleaning and storage (damage, replacement costs, safety hazards, etc.).

5. Design and lay out a storage device for one (1) of the following:

    a. Engine lathe tools generally used.
    b. Special engine lathe tools and attachments.
    c. Milling machine cutters.
    d. Grinding wheels.

6. Your instructor will supply an assortment of hand tools to be cleaned and stored.

    a. Clean tools.
    b. Place tools in storage.
    c. Have instructor evaluate your performance.

## Student Competency Sheet

### Unit XIV: MAINTAINING MACHINES AND TOOLS

### Module A: Cleaning and Storing Tools

### Task 3: STORE PRECISION TOOLS

---

## Performance Checklist

1. Handle all precision tools gently.
2. Inspect for damage.
3. Wipe surface free of dirt, grit, and oil.
4. Wipe surfaces dry to prevent rusting.
5. Apply light coat of tool and instrument oil.
6. Adjust tools, if necessary.
7. Store in proper case and clamp or close case.

## Test

Items Needed:
1. Several precision tools (selected by your instructor)
2. Clean rags
3. Tool and instrument oil
4. Rust preventative
5. Appropriate storage case

Task:
1. Prepare the precision tools for storage.
2. Store the precision tools.

Standard: All steps on the Instructor Check Sheet must be rated by your instructor as satisfactorily performed.

---

## Learning Activities

1. Read one (1) of the following:
    - a. Machining Fundamentals (Walker), pp. 29-56.
    - b. Metalwork Technology and Practices (Ludwig/McCarthy), pp. 75-83.
2. Read the precision tool manufacturer's storage and cleaning instructions, if available.
3. Observe demonstration by instructor:
    - a. Handling precision instruments.
    - b. Cleaning precision instruments.
    - c. Storing precision tools.

4. Examine precision tools provided by instructor.
    a. Name the tools.
    b. Sketch the tools; label parts.
    c. Demonstrate use of tools.
    d. Identify damages; or, if undamaged, identify possible kinds of damage.
    e. Research costs of precision instruments (tools).
    f. Discuss consequences of:
        (1) Improper care.
        (2) Using damaged precision instruments.

5. Practice cleaning and storing precision instruments.

6. Perform cleaning and storing of precision instrument. Have your instructor evaluate your performance.

INSTRUCTOR CHECK SHEET - STORAGE OF PRECISION TOOLS

| ACTIVITIES | RATING | |
|---|---|---|
| | ACCEPTABLE | NOT ACCEPTABLE |
| 1. Handling of tools. | | |
| 2. Noted damage, if any. | | |
| 3. Wiped free of dirt, grit and oil; dried. | | |
| 4. Applied light coat of instrument oil. | | |
| 5. Made appropriate adjustments. | | |
| 6. Stored tool in proper case. | | |
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## Student Competency Sheet

Unit XIV: MAINTAINING MACHINES AND TOOLS

Module B: Maintaining Machines

Task 1: INSTALL, LEVEL AND FASTEN DOWN MACHINES

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### Performance Checklist

Installation
1. Refer to operations and maintenance manual for sequence of installation.
2. Place machine in proper location and position.
3. Connect or have connected all electrical power.
4. Connect air supply (if applicable).

Leveling
1. Check level in all directions.
2. Adjust with shims or other leveling device, if necessary.

Lagging Down
1. Tighten down nuts or fasteners.
2. Check level with power off.
3. Check level with power on.
4. Adjust mounting, if necessary.
5. Check level in all directions

### Test

Items Needed:
1. Machine (selected by your instructor)
2. Proper installation equipment
3. Operations and maintenance manual
4. Shims
5. Master level
6. Wrenches
7. Assortment of hand tools
8. Assortment of fasteners

Tasks:
1. Install the machine.
2. Level the machine.
3. Fasten (lag down) the machine.

Standard:
1. The machine must be level, according to master level.
2. Your instructor must inspect and rate as satisfactory all activities on the Instructor Check Sheet.

---

### Learning Activities

1. Read manufacturer's manuals for sequence of installation.

2. Research types of fasteners available.

3. Attend lecture-demonstration by instructor on installing equipment.

4. Discuss safety practices and procedures.

5. Your instructor will assign a machine installation. As a class, research and discuss:

    a. Work area needed.
    b. Types of operations to be performed on machine.
    c. Installation procedures.
    d. Safety precautions and practices to be followed.

6. Your instructor will assign a machine installation:

    a. Research and write:
        (1) Work area needed.
        (2) Types of operations to be performed on machine.
        (3) Installation procedures.
        (4) Safety precautions and practices to be followed.
    b. If machine is not to be actually installed, point out/ demonstrate to instructor steps you would follow. Or...
    c. If machine is to be installed, carry out installation procedures with other classmates assigned to the task under supervision of your instructor.
    d. Have your instructor evaluate your performance.

INSTRUCTOR CHECK SHEET - INSTALLING MACHINE.

| ACTIVITIES | RATING | |
|---|---|---|
| | ACCEPTABLE | NOT ACCEPTABLE |
| 1. Machine positioned according to work order. | | |
| 2. Machine leveled to manufacturer's specs. | | |
| 3. Machine bolted securely in position. | | |
| 4. Work clearance of machine checked. | | |
| 5. Electrical system installed to manufacturer's specifications. | | |
| 6. Air supply connected (if applicable). | | |
| 7. Machine lubricated to specifications before applying power. | | |
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# Student Competency Sheet

Unit XIV: MAINTAINING MACHINES AND TOOLS

Module B: Maintaining Machines

Task 2: INSPECT AND REMOVE, REPLACE OR ADJUST MACHINE GUARDS

---

## Performance Checklist

1. Check operations and maintenance manual to account for all guards.
2. Obtain guards for those missing.
3. Inspect machine guards:
   a. Determine any defects.
   b. Determine any adjustments necessary.
   c. Remove damaged guards.
4. Replace/adjust guards:
   a. Replace missing or damaged guards.
   b. Adjust guards to manufacturer's specifications.

## Test

Items Needed:
1. Machine guards (selected by your instructor)
2. Operation and maintenance manual
3. Appropriate hand tools
4. Appropriate measurement instruments

Task: Follow manufacturer's specifications to:
1. Inspect machine guards.
2. Remove and replace machine guards, as necessary.
3. Adjust machine guards.

Standard: Your work must be:
1. In accordance with the manufacturer's specifications.
2. Be rated satisfactory by your instructor.

---

## Learning Activities

1. Read manufacturer's instruction manuals.

2. Research, write, and discuss the function of the guards on machines in your shop. Discuss when they should be removed, replaced, adjusted, or modified.

3. Point out and discuss guards on all machines in your shop.

4. In Safety Notebook, write:

    a. Five (5) safety practices to be put into practice before working on guard systems.
    b. Five (5) personal safety practices.

5. Attend demonstrations by instructor of inspecting, adjusting, and replacing guards.

6. Make a list of guards on machines in your shop:

    a. Sketch guards; label parts.
    b. List defects to look for in inspection.
    c. Discuss functions of the guards.
    d. Discuss use of hand tools to remove/adjust guards.

7. Your instructor will assign a shop machine:

    a. Inspect guards. List findings.
    b. Replace/adjust guards, as directed by instructor.
    c. Have instructor evaluate your work.

# Student Competency Sheet

## Unit XIV: MAINTAINING MACHINES AND TOOLS

### Module B: Maintaining Machines

### Task 3: REMOVE MACHINE PARTS

---

Performance Checklist

1. Secure and study work order and job specifications.
2. Select needed tools and equipment.
3. Cut off all power and lock switches to machinery.
4. Determine proper sequence for disassembly (if applicable).
5. Remove retaining fasteners.
6. Remove part(s).
7. Forward part(s) to appropriate work station for inspection, repair, or replacement.
8. Clean work station.
9. Clean and return tools and equipment to storage.

Test

Items Needed:
1. Work order
2. Job specifications
3. Appropriate tools and equipment
4. Cleaning materials

Task: Remove machine parts as directed in this work order and job specifications.

Standard: Your instructor must rate your performance of all activities on the Instructor Check Sheet as satisfactory.

---

Learning Activities

1. Read the manufacturer's operation and repair manuals for machines in your shop.

2. In Safety Notebook, write ten (10) general safety practices.

3. Obtain job work order from instructor:

    a. Select appropriate manual.
    b. Write a procedure check list for removing the part.
    c. Have instructor evaluate your procedure.

4. Learning Activity #3 can be repeated several times (for each machine assigned).

5. Repeat Learning Activity #3, and actually remove the part(s) and replace it (them) under the supervision of the instructor.

INSTRUCTOR CHECK SHEET - REMOVING MACHINE PARTS

| ACTIVITIES | RATING | |
|---|---|---|
| | ACCEPTABLE | NOT ACCEPTABLE |
| 1. Safety equipment utilized. | | |
| 2. Power at main braker turned off | | |
| and labeled "DO NOT OPERATE." | | |
| 3. Power controls at equipment in the off | | |
| position and labeled "DO NOT OPERATE." | | |
| 4. Machined surfaces protected from damage | | |
| from dropped parts or tools. | | |
| 5. Manufacturer's manual available for use. | | |
| 6. Proper tools available and utilized. | | |
| 7. Machine disassembled correctly | | |
| and carefully. | | |
| 8. Part repaired and correctly reinstalled. | | |
| 9. Machine put back together correctly. | | |
| 10. Bolts torqued to specs. | | |
| 11. Parts aligned and checked before connecting | | |
| power system. | | |
| 12. Test run performed. | | |
| 13. Work area cleaned up. | | |
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## Student Competency Sheet

Unit XIV: MAINTAINING MACHINES AND TOOLS

Module B: Maintaining Machines

Task 4: INSPECT AND CHANGE DRIVE PULLEYS OR BELTS

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### Performance Checklist

1. Cut off equipment electrical power.
2. Release belt tension.
3. Inspect belt for dryness, oil saturation, wear, stretching.
4. Determine if belt needs replacement.
5. Select replacement belt (if necessary):
    a. Select type (flat/Vee: and type of material).
    b. Measure belt for replacement.
    c. Select new belt.
    d. Splice or lace new belt (if necessary).
6. Inspect pulley for wear, cracks, replacement.
7. Remove and replace pulley (if necessary):
    a. Select type (flat/Vee)
    b. Measure for replacement.
    c. Remove pulley.
    d. Select new pulley.
    e. Place new pulley on shaft.
    f. Align pulley to shaft.
8. Install original or new belt:
    a. Align shafting and pulleys.
    b. Mount belt.
    c. Adjust belt tension.

### Test

Items needed:

1. Assortment of pulleys and belts
2. Wrenches
3. Pulley puller
4. Assortment of hand tools
5. Appropriate measurement instruments
6. Machinery handbook
7. Appropriate repair or maintenance manual

Task: In accordance with maintenance manual standards:

1. Inspect drive pulley or belt.
2. Change drive pulley or belt (as necessary according to repair or maintenance manual standards).

Standard: All activities on the Instructor Check Sheet must be rated by your instructor as satisfactorily performed.

---

Learning Activities

1. Read Metalwork Technology and Practices (Ludwig/McCarthy), pp. 173-178.

2. Attend lecture-demonstrations by instructor:

   a. Types of belt drives.
   b. Materials used in making belts.
   c. Machines in metal area that use belt drive systems.
   d. Pulleys
   e. Replacing and aligning pulleys.

3. In Safety Notebook, write:

   a. Three (3) personal safety practices.
   b. Three (3) general shop safety practices.

4. Write a report on materials used to make belts.

5. With a partner, examine machines in metal area that use belt drive systems. (Use safety precautions.)

   a. Note kinds of belts used.
   b. Discuss:
      (1) Properties (composition) of belts.
      (2) Reasons for use of specific materials in manufacturing the various belts.
      (3) How belts are powered (location, etc.).
      (4) Safe replacement techniques.

6. Obtain job work order from instructor.

   a. Inspect belt system (exercise safety precautions).
   b. Remove and replace defective parts.
   c. Have instructor inspect work before starting equipment.

INSTRUCTOR CHECK SHEET - INSPECT AND REPLACE COMPONENTS OF BELT DRIVE

| ACTIVITIES | RATING | |
|---|---|---|
| | ACCEPTABLE | NOT ACCEPTABLE |
| 1. Safety equipment utilized. | | |
| 2. Power to equipment shut off and labeled | | |
| "OUT OF SERVICE." | | |
| 3. Belt tension released. | | |
| 4. Belt inspected for wear or damage. | | |
| 5. Pulleys inspected for wear and damage. | | |
| 6. Pulley replacement: | | |
| a. Correct replacement part | | |
| b. Installed | | |
| c. Aligned | | |
| d. Secured | | |
| e. Proper tools used | | |
| 7. Belt replacement: | | |
| a. Correct belt type | | |
| b. Correct length | | |
| c. Laced or spliced correctly | | |
| d. Belt tension set to specifications | | |
| e. Proper tools used | | |
| 8. Tested for operational use. | | |
| 9. All guards replaced for operation | | |
| 10. Made test run. | | |
| 11. Work area cleaned. | | |

## Student Competency Sheet

Unit XIV: MAINTAINING MACHINES AND TOOLS

Module B: Maintaining Machines

Task 5: REPLACE AND ADJUST MACHINE PARTS

---

Performance Checklist

1. Secure and study work order and job specifications.
2. Receive inspected, repaired, or replacement part(s).
3. Inspect part(s) usability.
4. Determine and secure needed tools, equipment, and measurement instruments.
5. Determine proper sequence for assembly (if applicable).
6. Assemble all parts as required.
7. Replace all retaining fasteners as required.
8. Lubricate machine.
9. Make needed adjustments.
10. Check required machine part(s) movement by hand.
11. Make refinement adjustments, if necessary.
12. Check machine operation in low speed.
13. Test machine in all speeds and feeds as necessary.
14. Make necessary adjustments.
15. Clean work station.
16. Clean and return tools, equipment, and measurement instruments to storage.

Test

Items Needed:
1. Work order
2. Job specifications
3. Appropriate tools and equipment
4. Measurement instruments
5. Lubricants
6. Cleaning materials

Task:
1. Replace machine parts as directed in work order and job specifications.
2. Adjust machine parts as directed in work order and job specifications.

Standard: All activities on the Instructor Check Sheet must be rated by your instructor as satisfactorily performed.

---

Learning Activities

1. When equipment needs to be repaired, make the repair as a class project.

   a. Examine equipment to determine what is malfunctioning; determine if parts need replacement.
   b. Using manufacturer's parts list, order parts to be replaced.
   c. As a class, write a procedure checklist for replacing defective part(s).

2. Obtain job work order from instructor:

   a. Obtain necessary manuals and tools.
   b. Remove defective part(s).
   c. Order replacement part(s).
   d. Compare defective part(s) and new part(s).
   e. Reassemble equipment with new part(s).
   f. Test run equipment.
   g. Clean up work area.

INSTRUCTOR CHECK SHEET - REPLACEMENT AND ADJUSTMENT OF MACHINE PARTS

| | RATING | |
|---|---|---|
| ACTIVITIES | ACCEPTABLE | NOT ACCEPTABLE |
| 1. Safety equipment utilized. | | |
| 2. Power turned off and switches labeled "OUT OF SERVICE." | | |
| 3. Replacement part(s) inspected. | | |
| 4. Required tools utilized correctly. | | |
| 5. Parts assembled correctly. | | |
| 6. Fasteners installed correctly and torqued. | | |
| 7. Equipment lubricated. | | |
| 8. All guards in place and functional. | | |
| 9. Checked equipment movement by hand. | | |
| 10. Equipment tested at low speed. | | |
| 11. Equipment tested in all speeds and feeds. | | |
| 12. Work area cleaned. | | |
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## Student Competency Sheet

Unit XIV: MAINTAINING MACHINES AND TOOLS

Module B: Maintaining Machines

Task 6: SELECT COOLANTS, CUTTING OILS OR COMPOUNDS FOR MACHINE OPERATION

---

### Performance Checklist

1. Review job specifications and handbook tables.
2. Determine machinability of work piece.
3. Identify cutting tool material.
4. Consider severity of operation.
5. Determine machining operation.
6. Select coolant, cutting fluid, and/or compound.
7. Mix components when necessary.

### Test

| | |
|---|---|
| Items Needed: | 1. Job specifications<br>2. Work piece<br>3. Machinery handbook |
| Task: | Select coolant, cutting oil and/or compound for performing machining operations, according to job specifications and handbook table. |
| Standard: | Your instructor must inspect and approve your selections, according to the tables. |

---

### Learning Activities

1. Read the section on cutting oils and coolants in the Machinery's Handbook.

2. Read one of the following:

   a. Machining Fundamentals (Walker), pp. 252, 294-295, and 320.
   b. Metalwork Technology and Practices (Ludwig/McCarthy), pp. 165-172.

3. Research cutting fluids and their use on the following equipment:

   a. Hand tools
   b. Engine lathe
   c. Milling machines
   d. Grinders
   e. Cut-off equipment

4. Attend lecture-demonstration by instructor on:
    a. Selecting coolants and cutting oils.
    b. Handling coolants and cutting oils.

5. Make up a chart of coolants and their applications.

6. Discuss the consequences of:
    a. Not using coolants/cutting oils/compounds.
    b. Not using the correct coolants / cutting oils/compounds.

7. Your instructor will assign a workpiece and type of machine operation.
    a. Select correct coolants/cutting oils/compounds to be used.
    b. Explain your selection(s) to your instructor.
    c. Explain how to use the coolants/cutting oils/compounds.

## Student Competency Sheet

Unit XIV: MAINTAINING MACHINES AND TOOLS

Module B: Maintaining Machines

Task 7: SCRAPE AND PAINT MACHINES

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Performance Checklist

1. Cover machine parts not to be painted and work area.
2. Sand and scrape machine to bare metal.
3. Spray or brush primer coat (if applicable).
4. Allow primer coat to dry.
5. Select and stir machine paint.
6. Clean paint brushes or obtain new ones.
7. Paint exposed area with desired number of coats.
8. Clean brush and clamp lid back on paint can.
9. Store paint and brushes in appropriate places.
10. Pick up cover and dispose in proper container.
11. Clean machine and work area.

Test

Items Needed:

1. Machine to be painted
2. Paint
3. Paint brushes
4. Paint stick
5. Spray primer paint
6. Sandpaper
7. Steel wool
8. Scraper
9. Covercloth
10. Paint cleaner

Task:

1. Scrape machine
2. Paint machine

Standard: All activities on the Instructor Check Sheet must be rated by your instructor as satisfactorily performed.

---

Learning Activities

1. Research types of paint available:

   a. Oil base
   b. Latex
   c. Epoxy
   d. Lacquer

2. Read OSHA color coding. Discuss importance of adhering to this code when painting equipment.

3. Research and write a report on brushes: bristle, nylon, and polyester.

4. Observe demonstration by instructor on:
    a. Preparing surface and surrounding area.
    b. Applying primers and top coats.
    c. Safety practices.
    d. Use of strippers.

5. Research spray equipment:
    a. Spraying with compressor units.
    b. Electric spray units.
    c. Airless spray systems.

6. As directed by your instructor, prepare and paint a machine. Have your instructor evaluate your work.

INSTRUCTOR CHECK SHEET - PAINTING EQUIPMENT

| ACTIVITIES | RATING | |
|---|---|---|
| | ACCEPTABLE | NOT ACCEPTABLE |
| 1. Ventilation of work area. | | |
| 2. Protection of areas not being painted. | | |
| 3. Used stripper according to directions. | | |
| 4. Scraped, as required. | | |
| 5. Wire-brushed. | | |
| 6. Used abrasives correctly. | | |
| 7. Applied primer coat. | | |
| a. Used appropriate brush correctly. | | |
| b. Application. | | |
| c. Thinning (as required). | | |
| 8. Top coat(s). | | |
| a. Used appropriate brush correctly. | | |
| b. Application. | | |
| c. Thinning (as required). | | |
| 9. Cleaned work area. | | |
| 10. Cleaned paint equipment. | | |
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# UNIT XV

## PERFORMING PRODUCTION MACHINIST LINE WORK

### Terminal Objectives

Upon completion of the modules in this unit, you will be able to:

- Transfer drawings to tape for a numerical control machine
- Turn with an N/C machine
- Mill with an N/C machine
- Drill with an N/C machine
- Set up operation on an electrical discharge machine (EDM) in accordance with drawing specifications

## Student Competency Sheet

Unit XV: PERFORMING PRODUCTION MACHINIST LINE WORK

Module A: Numerical Control (N/C)

Task 1: TRANSFER DRAWING TO TAPE

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Performance Checklist

1. Obtain and read blueprint with complete specifications for numerical control.
2. Obtain and read program work sheet.
3. Obtain and read numerical control program manuals.
4. Tape program.

Test

Items Needed:
1. Blueprint
2. Program work sheets
3. Program manuals
4. Tape punch
5. Tape

Task: Program tape for numerical control equipment.

Standard: Tape will control machine to produce work piece to specification of drawing.

---

Learning Activities

1. Read two (2) of the following:
    a. Machining Fundamentals (Walker), pp. 341-353.
    b. Machinists Library; Basic Machine Shop (Black), pp. 441-458.
    c. Metalwork Technology and Practices (Ludwig/McCarthy), pp. 582-605.

2. Read N/C Instruction Course Student Manual (Stamass).

3. Attend lecture-demonstrations by instructor:
    a. Odd parity code and even parity code.
    b. Numerical control machines.
    c. Computer numerical control.
    d. Tape programming.

4. Write E1A code and ASC11 code (see Information Sheet XV-A-1).

5. Read and write code for Demonstration Sheet with Machine Sequence (Information Sheet XV-A-1a).

6. Prepare tape using Demonstration Sheet (Information Sheet XV-A-1a).

7. Write definitions for terms on Work Sheet XV-A-1b (Terms to Define).

   a. Discuss the terms.
   b. Ask your instructor for additional practice materials.

8. Obtain blueprint from instructor:

   a. Write sequence for N/C using Work Sheet XV-A-1c (Program Sheet).
   b. Have instructor evaluate your work.

## Information Sheet XV-A-1

EIA - RS 244A CODE
ODD PARITY

| 1 | 2 | 3 | SPROKET HOLES | 4 | 5 | 6 | 7 | 8 |  |
|---|---|---|---|---|---|---|---|---|---|
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| o |  |  |  |  |  |  |  |  | 1 |
|  | o |  |  |  |  |  |  |  | 2 |
| o | o |  |  |  | o |  |  |  | 3 |
|  |  | o |  |  |  |  |  |  | 4 |
| o |  | o |  |  |  |  |  |  | 5 |
|  | o | o |  |  | o |  |  |  | 6 |
| o | o | o |  |  |  |  |  |  | 7 |
|  |  |  |  | o |  |  |  |  | 8 |
| o |  |  |  | o | o |  |  |  | 9 |
| o |  |  |  |  |  | o | o |  | A |
|  | o |  |  |  |  | o | o |  | B |
| o | o |  |  |  | o | o | o |  | C |
|  |  | o |  |  |  | o | o |  | D |
| o |  | o |  |  | o | o | o |  | E |
|  | o | o |  |  | o | o | o |  | F |
| o | o | o |  |  |  | o | o |  | G |
|  |  |  |  | o |  | o | o |  | H |
| o |  |  |  | o | o | o | o |  | I |
| o |  |  |  |  | o |  | o |  | J |
|  | o |  |  |  | o |  | o |  | K |
| o | o |  |  |  |  |  | o |  | L |
|  |  | o |  |  | o |  | o |  | M |
| o |  | o |  |  |  |  | o |  | N |
|  | o | o |  |  |  |  | o |  | O |
| o | o | o |  |  | o |  | o |  | P |
|  |  |  |  | o | o |  | o |  | Q |
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| o | o |  |  |  |  | o |  |  | T |
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|  | o | o |  |  |  | o |  |  | W |
| o | o | o |  |  | o | o |  |  | X |
|  |  |  |  | o | o | o |  |  | Y |
| o |  |  |  | o |  | o |  |  | Z |
|  | o |  |  | o |  |  | o |  | " |
|  |  | o |  | o |  |  | o |  | $ |
| o |  | o |  | o | o |  | o |  | ? |
|  | o | o |  | o | o |  | o |  | = |
| o | o | o |  | o |  |  | o |  | ' (Apostrophe) |
| o | o |  |  | o | o | o |  |  | , (Comma) |
| o | o |  |  | o |  | o | o |  | . (Period) |
|  |  |  |  |  | o | o | o |  | + |
|  |  |  |  |  |  |  | o |  | - |
| o | o | o |  | o | o | o | o |  | ◘ (Delete) |
|  | o | o |  | o |  |  |  |  | ▲ (Tool Change) |
| o |  |  |  |  | o | o |  |  | (Rewind) |
| o | o |  |  | o | o |  | o |  | (Rewind Stop) |
| o | o |  |  | o |  |  |  |  | (M Function Rewind Stop) |
|  | o | o |  | o | o | o |  |  | ⊤ (TAB) |
|  |  |  |  |  |  |  |  | o | (C/R or EOB) |

## Information Sheet XV-A-1a

## DEMONSTRATION SHFET WITH MACHINE SEQUENCE

MACHINE TOOL

1. Select proper spindle speed. Make sure there is no power to machine when changing belts. Push off button on right side of power control panel.

2. Turn on start button on side of power control panel.

3. Turn on control console power switch.

4. Make sure master stop button is not on.

5. Turn on power switch on digital display.

6. Load first work piece in vise. Make sure there are stops in X and Y axis of vise for accurate relocation of every work piece.

   The N/C machine is now ready for manual positioning of the spindle.

7. Put the machine into manual by depressing the manual mode switch on the control console. This enables 3 axis manual control of the machine with the joy stick.

8. Insert an edge finder in spindle for location of X and Y axis.

9. With the joy stick move the "X" axis in a - direction at least .050 past the zero (starting) point. From the + X direction bring the edge finder to the starting point of the "X" axis. For manual positioning of spindle to starting point always position from the direction to take backlash from the screws. Zero the X axis digital display.

10. With the joy stick move the "Y" axis to the starting position. Use the same procedure as "X" axis (step 9). Zero the "Y" axis digital display.

    The X and Y axis is now set to the starting point.

11. To set the "Z" axis, remove the edge finder from the spindle. Insert the cutting tool to be used in the program. Bring the spindle down (-Z), to the top of the work piece. Zero the "Z" axis digital display. Move the "Z" axis in the + .050. This positions the "Z" axis to the running position.

    The machine is ready to operate the machine from the keyboard of the TPC.

Information Sheet XV-A-1a (Continued)

12. Tape Preparation Center
    - A. Turn the on-off transmit switch on the TPC to the transmit position.
    - B. Push the punch "on" on the punching unit. This enables a tape to be made as the machine is programmed from the keyboard.
    - C. The reader switch should be in the stop position.
    - D. Turn on the printout switch on the top of the faceplate.
    - E. Insert the program sheet in the copyboard holder.

13. N/C Console
    - A. Push on the auto switch of the mode switches.
    - B. Push on the start switch of the mode switches.
    - C. Check to see that the X and Y axis digital display are zeroed.
    - D. The Z axis digital display should read the amount the spindle is above the work piece (this job is .050").
    - E. Set the switch on the digital display to "incremental" this automatically zeros each display before each movement, this enables the checking of each movement.
    - F. Zero the sequence counter.

The following pages contain a simple N/C program. First, there is a drawing with complete instructions. Second, there is the written N/C program for this job. From the program sheet the information is typed on the keyboard of the tape preparation center exactly as written. The only information that is not typed are the instructions.

By using the instructions, the machine tool will perform the commands as typed. At the same time a tape will be made of the program and a program printout.

The following is a sequence by sequence description of the program.

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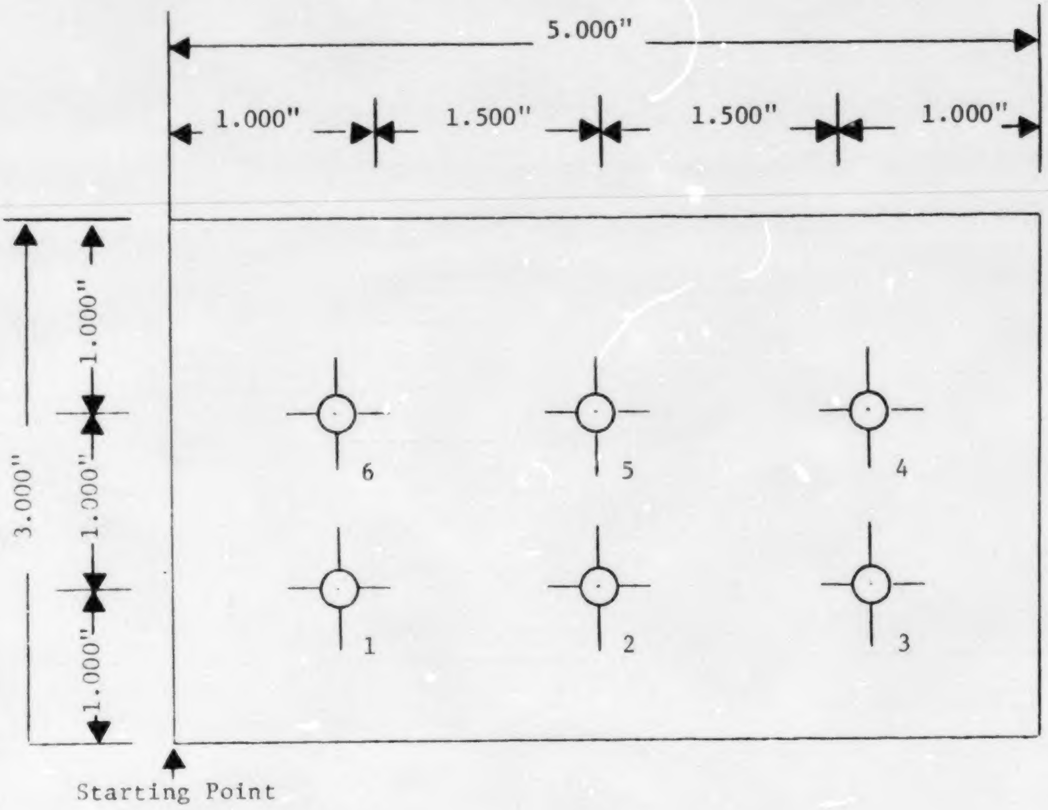
Information Sheet XV-A-la (Continued)


5.000"
1.000"
1.500"
1.500"
1.000"
3.000"
1.000"
1.000"
1.000"
6
5
4
1
2
3
Starting Point

Problem example number 1

Problem name Drill Block

Size of work piece 1" x 3" x 5"

Material Aluminum, Plastic or Wood

Number of operations 6

Number of tool changes 0

Tools used A - 1/4" drill

Tool depth A - .375"

Drilling speed A - 6 IPM

Positioning speed 120 IPM

Backlash .015"

Positioning height above work piece .050"

Instructions: Drill 6 holes per attached drawing

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Information Sheet XV-A-1a (Continued)

From the drawing and instructions we have all the information needed to prepare our program sheet. Problem No. 1 is to drill six 1/4" holes, .375" deep in a 1" x 3" x 5" piece of material. Take the drill that has been placed in the quick change drill chuck and locate it in the No. 1 hole on the tool convenience board.

All of the following work will be performed from the keyboard of the Tape Preparation Center. From the keyboard make a leader by pushing the space bar and the rept keys simultaneously. The length of the leader should be approximately 25 spaces long.

TAB EOB
The carriage of the typing unit will move to the left margin. The sequence counter will advance to 1 to show the machine will be performing the first sequence.

1 TAB 1 D, TAB, EOB
1 - is the sequence number
TAB 1 D, Advances status display to 1
TAB, EOB Stops the system. Take the tool from the No. 1 position on the tool convenience board and insert it in the spindle. Re-start the system by pushing the start mode switch on the N/C Console. Moves carriage to left and advances sequence counter No. 2.

2 TAB 1+E EOB
2 - is the sequence number
TAB 1+E Turns the spindle ON
EOB Moves the carriage to the left and advances the sequence counter to 3.

3 TAB 2+E EOB
3 - is the sequence number
TAB 2+E Turns the lubrication system ON
EOB Moves the carriage to the left and advances the sequence counter to 4.

4 TAB 1 F EOB
4 - is the sequence number
TAB 1 F Puts the system into rapid traverse for positioning from the starting point to drill No. 1 hole
EOB Moves the carriage to the left and advances the sequence counter to 5.

5 TAB 1000+X, TAB 1000+Y, TAB 6F, TAB 425-Z, TAB 1F, TAB 425+Z EOB
5 - is the sequence number
TAB 1000+X, Moves the spindle +X 1.000"
TAB 1000+Y, Moves the spindle +Y 1.000". The spindle is positioned above hole No. 1
TAB 6F, Changes the feed to 6 in/min. for drilling hole No. 1
TAB 425-Z, Drills No. 1 hole
TAB 1F, Changes to rapid traverse for retracting out of hole and positioning to hole No. 2
TAB 425+Z Retracts spindle out of hole No. 1
EOB Moves the carriage to the left and advances sequence counter to 6.

Information Sheet XV-A-1a (Continued)

6 TAB 1500+X, TAB 6F, TAB 425-Z, TAB 1F, TAB 425+Z EOB
6 - is the sequence number
TAB 1500+X, Moves the spindle+X 1.500" positioning the spindle above hole No. 2
TAB 6F, Changes the feed to drill No. 2 hole
TAB 425-Z, Drills No. 2 hole
TAB 1F, Changes to rapid traverse
TAB 425+Z Retracts spindle out of No. 2 hole
EOB Moves carriage to the left and advances sequence counter to No. 7.

7 TAB 1500+X, TAB 6F, TAB 425-Z, TAB 1F, TAB 425+Z EOB
7 - is the sequence number
TAB 1500+X, Moves spindle+X 1.500" positioning the spindle above No. 3 hole
TAB 6F, Changes feed to drill No. 3 hole
TAB 425-Z, Drills No. 3 hole
T1F, Changes to rapid traverse
TAB 425+Z Retracts spindle out of hole No. 3
EOB Moves the carriage to the left and advances sequence counter to 8.

8 TAB 1000+Y, TAB 6F, TAB 425-Z, TAB 1F, TAB 425+Z EOB
8 - is the sequence number
TAB 1000+Y, Moves the spindle +Y 1.000" positioning the spindle above No. 4 hole
TAB 6F, Changes feed to drill No. 4 hole
TAB 425-Z, Drills No. 4 hole
TAB 1F, Changes to rapid traverse
TAB 425+Z Retracts spindle out of hole No. 4
EOB Moves the carriage to the left and advances sequence counter to 9.

9 TAB 1515-X, TAB 15+X, TAB 6F, TAB 425-Z, TAB 1F, TAB 425+Z EOB
9 - is the sequence number
TAB 1515-X, Moves the spindle -X 1.500" plus 0.015" backlash positioning the spindle above hole No. 5
TAB 15+X, Moves the spindle + X0.015" removing backlash
TAB 6F, Changes feed to drill No. 5 hole
TAB 425-Z, Drills No. 5 hole
TAB 1F, Change to rapid traverse
TAB 425+Z Retracts spindle out of No. 5 hole
EOB Moves the carriage to the left and advances sequence counter to 10.

10 TAB 1515-X, TAB 15+X, TAB 6F, TAB 425-Z, TAB 1F, TAB 425+Z EOB
10 - is the sequence number
TAB 1515-X, Moves the spindle -X 1.500" plus 0.015" backlash positioning the spindle above the hole No. 6
TAB 15 +X, Moves the spindle +X0.015" removing backlash
TAB 6F, Changes feed to drill No. 6 hole
TAB 425-Z, Drills No. 6 hole
TAB 1F, Changes to rapid traverse
TAB 425+Z Retract spindle out of hole No. 6
EOB Moves the carriage to the left and advances sequence counter to 11.

Information Sheet XV-A-1a (Continued)

11 TAB 1015-X, TAB 15+X, TAB 2015-Y, TAB 15+Y EOB
11 - is the sequence number
TAB 1015-X, Moves the spindle -X 1.000" plus 0.015" backlash
TAB 15+X, Moves the spindle +X 0.015" removing backlash
TAB 2015-Y, Moves the spindle -Y 2.000" plus 0.015" backlash
TAB 15+Y, Moves the spindle +Y 0.015" removing backlash spindle back to zero
EOB Moves the carriage to the left and advances sequence counter to 12.

12 TAB 1-E EOB
12 - is the sequence number
TAB 1 E Turns OFF the spindle
EOB Moves the carriage to the left and advances the sequence counter to 13.

13 TAB 2-E EOB
13 - is the sequence number
TAB 2-E Turns OFF the lubrication system
EOB Moves the carriage to the left and advances sequence counter to 14.

END OF PROGRAM

MAKE LEADER FOR END OF TAPE

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Information Sheet XV-A-1a (Continued)

# MERITMATIC N/C — PROGRAM SHEET

| | | |
|---|---|---|
| DATE 1/10/72 | NAME Drill Block | JOB No E 1<br>SHEET 1 OF 1 |
| CP BY<br>DATE | REMARKS | |
| JOB No 1 OF 1 | | |
| CLASS | | |
| TAPE NO E-1 | | |

| SEQ | COMMAND | COMMAND | COMMAND | EOB | INSTRUCTIONS |
|---|---|---|---|---|---|
| | | | | TAB EOB | Set sequence counter to 1 |
| 1 | TAB 1D | | | TAB EOB | Status 1, Insert 1/4" drill |
| | | | | | Load workpiece, start |
| 2 | TAB 1 +E | | | EOB | Spindle On |
| 3 | TAB 2 +E | | | EOB | Lub on |
| 4 | TAB 1F | | | EOB | Feed rapid |
| 5 | TAB 1000 +X | TAB 1000 +Y | TAB 6F | | |
| | TAB 425 −Z | TAB 1F | TAB 425 +Z | EOB | Drill #1 hole |
| 6 | TAB 1500 +X | TAB 6F | TAB 425 −Z | | |
| | TAB 1F | TAB 425 +Z | | EOB | Drill #2 hole |
| 7 | TAB 1500 −Y | TAB 6F | TAB 425 −Z | | |
| | TAB 1F | TAB 425 +Z | | EOB | Drill #3 hole |
| 8 | TAB 1000 +X | TAB 6F | TAB 425 −Z | | |
| | TAB 1F | TAB 425 +Z | | EOB | Drill #4 hole |
| 9 | TAB 1515 −X | TAB 15 +Y | TAB 6F | | |
| | TAB 425 −Z | TAB 1F | TAB 425 +Z | EOB | Drill #5 hole |
| 10 | TAB 1515 −X | TAB 15 +Y | TAB 6F | | |
| | TAB 425 −Z | TAB 1F | TAB 425 +Z | EOB | Drill #6 hole |
| 11 | TAB 1015 −X | TAB 15 +Y | TAB 2015 −Y | | |
| | TAB 15 +Y | | | EOB | Back to zero |
| 12 | TAB 1 −E | | | EOB | Spindle off |
| 13 | TAB 2 −E | | | EOB | Lub off |
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WORK SHEET XV-A-1b

TERMS TO DEFINE

Point to point machining

Continuous path

Contour machining

Cartesian coordinate system

Quadrant

X axis

Y axis

Z axis

Two axis machine

Binary number system

Parity check

Odd parity

Even parity

ElA

ASCII

EOB

TAB

WORK SHEET XV-A-1c

N/C PROGRAM SHEET

| | | |
|---|---|---|
| DATE | NAME | JOB No<br>SHEET 1 OF 1 |
| [illegible]<br>DATE | REMARKS | |
| JOB No OF | | |
| CLASS | | |
| TAPE NO | | |

| SEQ | COMMAND | COMMAND | COMMAND | EOB | INSTRUCTIONS |
|---|---|---|---|---|---|
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## Student Competency Sheet

Unit XV: PERFORMING PRODUCTION MACHINIST LINE WORK

Module A: Numerical Control (N/C)

Task 2: TURN WITH N/C MACHINE

---

Performance Checklist

1. Obtain blueprint.
2. Obtain machinist work sheet.
3. Obtain work piece.
4. Set up N/C lathe.
5. Mount work piece and set tool to zero or start point.
6. Obtain tape; feed tape to control unit.
7. Machine, by using tape.

Test

Items Needed:
1. N/C engine lathe set up
2. Work piece
3. Blueprint
4. N/C tape programmed for blueprint
5. Machinist work sheet

Task: Machine work piece using N/C lathe.

Standard:
1. N/C lathe will be set up to specifications.
2. Work piece will be machined to specifications.

---

Learning Activities

1. Read N/C lathe operational manual.

2. Attend lecture-demonstration by instructor:

    a. Setting up N/C lathe.
    b. Programming N/C lathe.
    c. Operating N/C lathe.
    d. Setting up and operating CNC lathes.

3. In Safety Notebook, write:

    a. Five (5) personal safety practices.
    b. Five (5) general shop safety practices.

4. Practice using N/C lathe.

5. Obtain blueprint and N/C lathe tape program:

   a. Set-up N/C lathe with work piece.
   b. Have instructor check set-up.
   c. Operate N/C lathe with tape program.
   d. Clean up work area.
   e. Submit work piece to instructor for evaluation.

## Student Competency Sheet

## Unit XV: PERFORMING PRODUCTION MACHINIST LINE WORK

### Module A: Numerical Control (N/C)

### Task 3: MILL WITH N/C MACHINE

---

### Performance Checklist

1. Obtain blueprint.
2. Obtain machinist work sheet.
3. Obtain work piece.
4. Set up N/C milling machine.
5. Mount work piece and set tool to zero or starting point.
6. Obtain tape; and feed tape into control unit.
7. Machine work piece by using tape.

### Test

Item Needed:
1. N/C milling machine set-up
2. Work piece
3. Blueprint
4. Machinist work sheet
5. N/C tape programmed for blueprint

Task: Machine work piece, using N/C milling machine.

Standard:
1. N/C milling machine will be set up to specifications.
2. Work piece will be machined to specifications.

---

### Learning Activities

1. Read N/C milling machine operation manual.

2. Attend lecture-demonstration by instructor:

    a. Setting up N/C milling machine.
    b. Programming N/C milling machine.
    c. Operating N/C mill.
    d. Set-up and operation of CNC milling machines.

3. In Safety Notebook, write:

    a. Five (5) personal safety practices.
    b. Five (5) general shop safety practices.

4. Write an explanation of three-axis N/C machines; X, Y, and Z axis.

5. Practice using N/C mill.

6. Obtain job work order from instructor:

   a. Obtain necessary tools, work piece, blueprint, machinist work sheet, N/C tape.
   b. Set up N/C milling machine.
   c. Have instructor check set-up.
   d. Operate N/C mill with tape program.
   e. Clean up work area.
   f. Submit work piece to instructor for evaluation.

## Student Competency Sheet

Unit XV: PERFORMING PRODUCTION MACHINIST LINE WORK

Module A: Numerical Control (N/C)

Task 4: DRILL WITH N/C MACHINE

---

### Performance Checklist

1. Obtain blueprint and machinist work sheet.
2. Obtain work piece.
3. Set up N/C equipment:
   a. N/C drill press
   b. N/C vertical milling machine
4. Mount work piece and set tool to zero or starting point.
5. Obtain tape; and feed tape into control unit.
6. Machine work piece, using tape.

### Test

Items Needed:
1. N/C drill press
2. N/C milling machine
3. Blueprint
4. Machinist work sheet
5. N/C tape program

Task: Drill work piece, using N/C system.

Standard:
1. N/C equipment will be set up to specifications.
2. Work piece will be machined to specifications.

---

### Learning Activities

1. Read operational manual for N/C:

   a. Drill press
   b. Drilling on vertical mill

2. Attend lecture-demonstration by instructor:

   a. Setting-up N/C drill press.
   b. Setting-up N/C vertical mill for drilling.
   c. Reading machinist work sheet.
   d. Operating N/C drill press.
   e. Operating N/C vertical mill.

3. In Safety Notebook, write:
    a. Five (5) personal safety practices.
    b. Five (5) general shop safety practices.

4. Practice using N/C drill press.

5. Practice using N/C vertical mill for drilling.

6. Obtain job work order from instructor:
    a. Select tools, work piece, N/C tape, blue print and machinist work sheet.
    b. Set up N/C equipment.
    c. Mount work piece; set tool to zero or starting point.
    d. Have instructor check set-up.
    e. Drill work piece, using tape.
    f. Clean up work area.
    g. Have instructor evaluate work piece.

# Student Competency Sheet

## Unit XV: PERFORMING PRODUCTION MACHINIST LINE WORK

### Module B: Electrical Discharge Machine (EDM)

### Task 1: SET UP OPERATION PER DRAWING SPECIFICATIONS

---

Performance Checklist

1. Form electrode to requirements of blueprint.
2. Mount electrode.
3. Secure work piece and align.
4. Set up hydraulic servo-system.
5. Set up dielectric flow.
6. Machine work piece to specifications.

Test

Items Needed:
1. EDM unit
2. Blueprint
3. Electrode

Task: Machine with EDM unit.

Standard: Work piece must be machined to + 0.0002" tolerance.

---

Learning Activities

1. Read one (1) of the following:
   a. Machining Fundamentals (Walker), pp. 427-432.
   b. Machinists Library; Basic Machine Shop (Black), pp. 53-65.
2. Read the manufacturer's operation manual.
3. Attend lecture-demonstration by instructor:
   a. Advantages of EDM.
   b. Setting-up EDM.
   c. Machine tool steels.
   d. Electrode preparation.
   e. Machining irregular shapes with EDM.
4. In Safety Notebook, write:
   a. Five (5) personal safety practices.
   b. Five (5) general shop safety practices.

5. Practice setting-up EDM unit.

6. Design irregular shape electrode to be used on EDM. Set up and test electrode.

7. Write a list of advantages to EDM.

8. Identify and discuss local companies that are currently using EDM:

   a. Identify products of the companies.
   b. Discuss advantages and disadvantages which will enhance or retard the use of EDM.

9. Obtain job work order from instructor:

   a. Select and mount preshaped electrode or prepare electrode of specified shape; mount.
   b. Secure and align work piece.
   c. Fill work chamber with EDM fluid; set pump system.
   d. Set servo system.
   e. Machine to specifications.
   f. Clean up work area.
   g. Submit work piece to instructor for evaluation.